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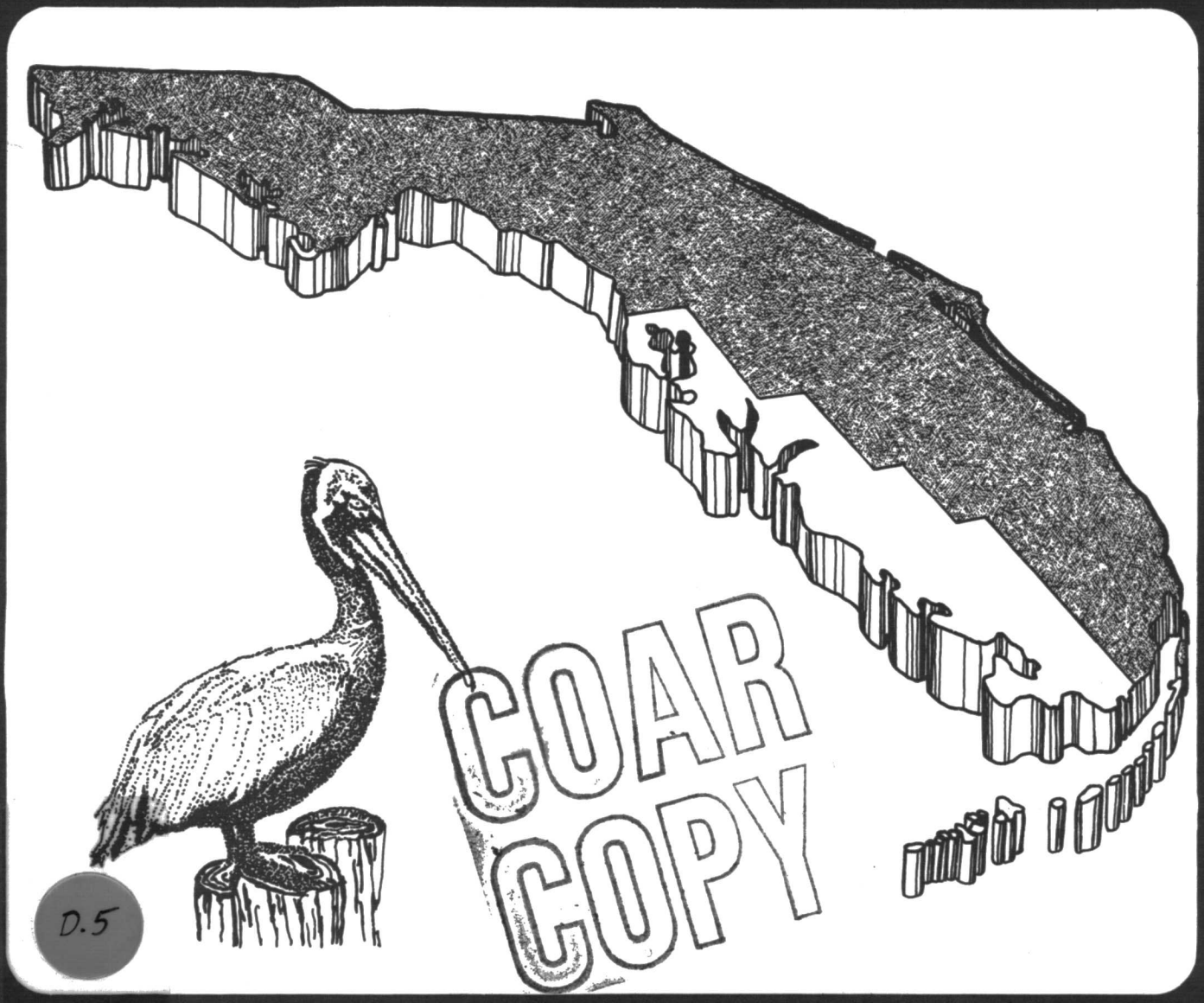
February 1983

RARE, THREATENED, AND ENDANGERED VERTEBRATES OF SOUTHWEST FLORIDA AND POTENTIAL OCS ACTIVITY IMPACTS



Bureau of Land Management
Fish and Wildlife Service

U.S. Department of the Interior

FWS/OBS-82/03
February 1983

Rare, Threatened, and Endangered Vertebrates of Southwest Florida and Potential OCS Activity Impacts

by

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PREFACE

This report on rare, threatened, and endangered vertebrates is a compilation of all species so designated or considered for listing by various Federal, State, and private institutions and organizations. It identifies the vertebrates of southwest Florida that potentially could be affected by Outer Continental Shelf (OCS) development.

This report does not constitute or designate official status for all of the vertebrates described herein, even though Federally listed species are included. Information about the current Federal status of taxa occurring in Florida may be obtained from the U.S. Fish and Wildlife Service Regional Office in Atlanta, Georgia (Region 4) at the address listed on the inside back cover of this report.

The U.S. Fish and Wildlife Service and the Bureau of Land Management have cooperated to prepare this document and a companion report that describes the rare, threatened, and endangered plant species of the southwest Florida coast. The Bureau of Land Management, New Orleans OCS Office, has recently been transferred to the Minerals Management Service, Gulf of Mexico OCS Region.

Questions or suggestions about these reports should be directed to:

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SUMMARY

The eight southwestern Florida gulf coast counties (Pinellas, Hillsborough, Manatee, Sarasota, Charlotte, Lee, Collier and Monroe) include populations of 68 vertebrates considered rare, threatened, or endangered by the Fish and Wildlife Service or the Florida Committee on Rare and Endangered Plants and Animals. This report assesses the potential impact of Outer Continental Shelf (OCS) oil exploration and production on these animals.

The terrestrial and near-shore habitats of the study area and the habitat preferences of each of the 68 vertebrates are described. Each vertebrate is listed in the habitats it occupies, and information about reproduction, feeding, and where available, population estimates, is given under the habitat considered most important for each species.

The distributions of the rare, threatened, and endangered vertebrates by county and habitat demonstrate the relative importance of the southernmost counties (Monroe and Collier) and wetland and coastal habitats (strand, mangrove/marsh, estuaries).

Human activities contributing to the decline of these 68 vertebrates are also assessed. Direct exploitation and incidental disturbance are important for about one-third of the vertebrates considered in the report, but habitat loss is overwhelmingly more important for all. There is a large number of rare, threatened, and endangered vertebrates associated with wetlands, and though there is extensive preservation of wetlands (e.g., Everglades National Park) unsound water management practices are deteriorating these habitats as well.

Human land use and population trends are described. The rapidly increasing human population in southwest Florida forebodes continued and increasingly rapid loss of natural habitats.

Potential impacts of OCS development are assessed by describing associated events (onshore development, pipeline construction, OCS activity) and estimating the effects each activity might have on various habitats. Direct impact of OCS development is estimated to be small. Oil spills are considered the most dangerous result of development and the habitats contiguous with marine waters (strand, mangrove/marsh, estuaries) are the most susceptible to damage. These are also the habitats identified as harboring the largest number of rare and endangered vertebrates in southwest Florida.

Two localities are considered likely for onshore OCS installations, Port Manatee and Boca Grande. Of these, Boca Grande is deemed the most sensitive because it is nearer the critical southern counties, and it is less developed than Port Manatee.

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ABBREVIATIONS

BLM	Bureau of Land Management, U.S. Department of the Interior
CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna
FCREPA	Florida Committee on Rare and Endangered Plants and Animals
FDA	Florida Department of Administration
FDACS	Florida Department of Agriculture and Consumer Services
FS	Forest Service, U.S. Department of Agriculture
FWS	Fish and Wildlife Service, U.S. Department of the Interior
GS	Geological Survey, U.S. Department of the Interior
LUDA	Land Use and Data Analysis
OCS	Outer Continental Shelf
USDI	U.S. Department of the Interior

ACKNOWLEDGMENTS

The methods used in the analyses of habitats were developed from consultations with Dr. Earl D. McCoy, who also designed the maps. Research assistant John Juilianna gathered many of the data on the habitats. Lisa A. Hanners typed early drafts of the manuscript. Cherry Keller was an extremely helpful and patient Project Officer. The technical and editorial staff of the National Coastal Ecosystems Team reviewed and helped prepare the final manuscript for publication. I greatly appreciate the assistance of all of these persons.

INTRODUCTION

In accordance with the Department of the Interior's Outer Continental Shelf (OCS) Oil and Gas Leasing Schedule for the Gulf of Mexico, Sale 66 was held on 20 October 1981. Sale 66 included about ninety 5760-acre tracts off the west-central coast of Florida (Bureau of Land Management [BLM] 1980). Proposed OCS Sales 67 and 69 are scheduled for March and August 1982, respectively. These sales include about forty-eight 5760-acre tracts also off the west-central coast of Florida (BLM 1981). Additional tracts are scheduled to be leased through 1986. Exploratory wells may be drilled in many of these tracts. Offshore production will begin if substantial reserves are discovered, oil and gas will be gathered by new pipelines, terminating at a central point for storage and transfer to shuttle tankers. The central point is expected to be somewhere between Tampa Bay and Naples. Probably the existing facilities at Port Manatee will be used and expanded (BLM 1980, 1981).

This report will evaluate the potential impact of OCS oil exploration and production activities on the habitats of the rare, threatened, and endangered vertebrates of southwest Florida. Southwest Florida is defined as the eight counties that include open gulf coastline from Tampa Bay to the Keys: Pinellas, Hillsborough, Manatee, Sarasota, Charlotte, Lee, Collier and Monroe (Figure 1). DeSoto County, which has a short border along the upper reaches of Charlotte Harbor, is excluded. Thus it is the eight counties included in the report that are most likely to be affected by OCS oil activities in the sale tracts named.

The report emphasizes habitats. The rationale for this approach appears in the Endangered Species Act of 1973 (U.S. Congress 1973):

> "The purposes of this Act are to provide means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of...treaties and conventions...."

The intent of the report is to identify the rare and endangered vertebrates of southwest Florida, to describe their habitats, and to discuss the current strains on these habitats caused by man. With this information, any additional impacts caused by OCS development can be evaluated. These evaluations form the final section of the report.

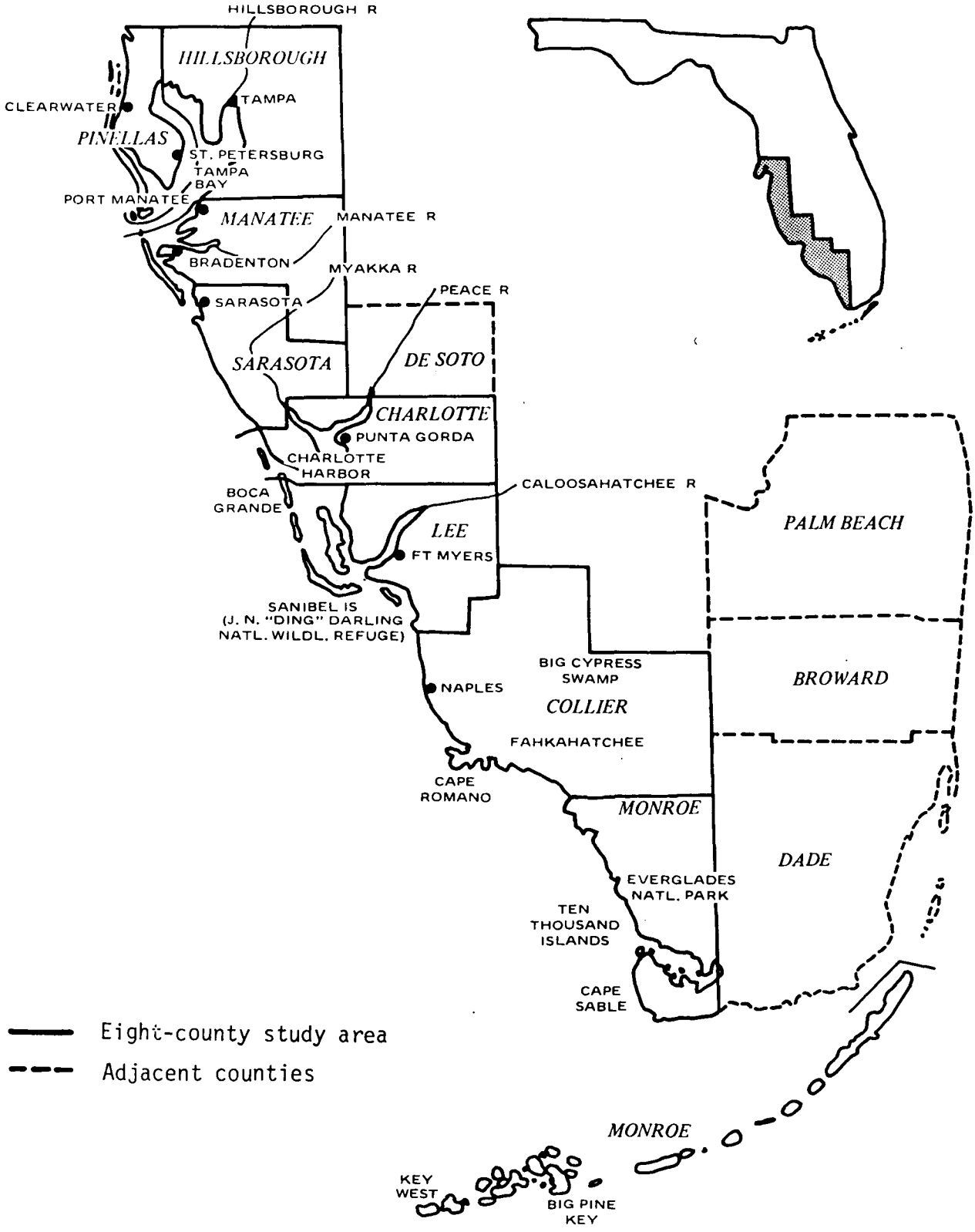

Figure 1. Map of Florida and southern coastal counties.

RARE, THREATENED, AND ENDANGERED VERTEBRATES OF SOUTHWEST FLORIDA AND THEIR HABITATS

SPECIES CONSIDERED IN THIS REPORT

Sixty-eight terrestrial and near-shore vertebrate taxa whose populations in southwest Florida could be reduced to non-sustaining levels by human activities are considered in this report. These include legally protected vertebrates that are on State and Federal endangered species lists, and those that are considered rare but at present have no legal protection. Table 1 lists all 68 vertebrates, the five sources used in compiling the list, and the status of each of the vertebrates on these listings.

Of the five sources used, most inclusive were the four volumes prepared by the Florida Committee on Rare and Endangered Plants and Animals (FCREPA) (Pritchard 1978). Only five of the 68 species listed are not treated in these volumes. Legal protection of endangered or potentially endangered vertebrates is provided only for species listed by the United States Fish and Wildlife Service (FWS), the Game and Fresh Water Fish Commission of Florida (GFWFC), and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES 1976). Three vertebrates not discussed by FCREPA, the marsh hawk, river otter, and bobcat, are listed by CITES.

The National Audubon Society (NAS) regularly publishes in their journal American Birds a "Blue List" of bird species "recently or currently giving indications of non-cyclical population declines." With this reference the status of many of the birds on the FCREPA list are corroborated, and two species were added: the common loon and American bittern. These two species are included on the most recent of the several Blue Lists published in American Birds (Arbib 1979).

The species listed in Table 1 have declining or vulnerable populations. Populations decline and eventually can disappear when the number of individuals lost from the population (mortality) exceeds the number being added (natality). Information necessary to demonstrate the extent of a population decline usually is unavailable because of the vast amount of time needed to gather these population data in the field. However, because the tentative 1982 OCS leasing schedule proposes two lease sales in the Gulf of Mexico, it is necessary to compile available information and make recommendations for these vertebrate populations now.

The list of 68 vertebrates includes all that have been or would be affected by extensive loss of their habitat in the eight southwest Florida counties. These vertebrates include (1) species with wide distributions and severely depressed populations (e.g., green sea turtle), and (2) species with limited distributions, where decreases of the populations in southwest Florida would have a significant negative effect on the entire population (e.g., Florida mouse). Vertebrates whose ranges include southwest Florida, but for which even total elimination of habitat in the eight counties would have little effect on their populations, are excluded. Examples of such excluded species are the golden eagle (Aquila chrysaetos) and merlin (Falco columbarius).

Table 1. Rare, threatened, and endangered vertebrates of the eight southwest Florida counties, and sources for the species' status.

Vertebrate taxon		Sources and status[a]				
Common name	Scientific name	FCREPA	FWS	GFWFC	CITES	NAS
FISHES						
Atlantic sturgeon	Acipenser oxyrhynchus	T		SC	II	
Key silverside	Menidia conchorum	E		E		
Rivulus	Rivulus marmoratus	T		SC		
Key blenny	Starksia starcki	T		SC		
AMPHIBIAN						
Gopher frog	Rana areolata	T		SC		
REPTILES						
American crocodile	Crocodylus acutus	E	E	E	I	
American alligator	Alligator mississippiensis	SC	T	SC	II	
Leatherback sea turtle	Dermochelys coriacea	R	E	E	I	
Green sea turtle	Chelonia mydas	E	E	E	I	
Hawksbill sea turtle	Eretmochelys imbricata imbricata	E	E	E	I	
Kemp's Ridley sea turtle	Lepidochelys kempii	E	E	E	I	
Loggerhead sea turtle	Caretta caretta caretta	T	T	T	I	
Key mud turtle	Kinosternon bauri bauri	T		T		
Suwannee cooter	Chrysemys concinna suwanniensis	T	UR	SC		
Gopher tortoise	Gopherus polyphemus	T		SC	II	
Short-tailed snake	Stilosoma extenuatum	E	UR	T		
Big Pine Key ringneck snake	Diadophis punctatus acricus	T		T		
Red rat snake (Lower Keys only)	Elaphe guttata guttata	T		SC		

(continued)

Table 1. Continued.

Vertebrate taxon		Sources and status[a]				
Common name	Scientific name	FCREPA	FWS	GFWFC	CITES	NAS
Florida brown snake (Lower Keys only)	Storeria dekayi victa	T		T		
Miami black-headed snake	Tantilla oolitica	T	UR	T		
Eastern indigo snake	Drymarchon corais couperi	SC	T	T		
Florida ribbon snake (Lower Keys only)	Thamnophis sauritus sackeni	T		T		
BIRDS						
Common loon	Gavia immer					L
Brown pelican	Pelecanus occidentalis	T	E	T		
Magnificent frigatebird	Fregata magnificens	T				
American bittern	Botaurus lentiginosus					L
Least bittern	Ixobrychus exilis	SC				L
Great white heron	Ardea herodias occidentalis	SC				
Snowy egret	Egretta thula	SC		SC		L
Little blue heron	Egretta caerulea	SC		SC		
Louisiana heron	Egretta tricolor	SC		SC		
Reddish egret	Egretta rufescens	R		SC		
Roseate spoonbill	Ajaia ajaja	R		SC		
Wood stork	Mycteria americana	E		E		L
Small kite	Rostrhamus sociabilis plumbeus	E	E	E		
Bald eagle	Haliaeetus leucocephalus	T	E	T	I	
Northern harrier	Circus cyaneus				II	L
Crested caracara	Polyborus plancus auduboni	T		T		

(continued)

Table 1. Continued.

Vertebrate taxon		Sources and status[a]				
Common name	Scientific name	FCREPA	FWS	GFWFC	CITES	NAS
American kestrel	Falco sparverius	T		T	II	L
Peregrine falcon	Falco peregrinus	E	E	E	I	
Limpkin	Aramus guarauna	SC		SC		
Sandhill crane	Grus canadensis	T		T	II	
Snowy plover	Charadrius alexandrinus	E		E		L
Piping plover	Charadrius melodus	SC				L
American oystercatcher	Haematopus palliatus	T		SC		
Roseate tern	Sterna dougallii	T		T		L
Least tern	Sterna antillarum	T		T		L
White-crowned pigeon	Columba leucocephala	T		T		
Burrowing owl	Athene cunicularia	SC		SC		L
Red-cockaded woodpecker	Picoides borealis	E	E	T		
Ivory-billed woodpecker	Campephilus principalis	E	E	E		
Florida scrub jay	Aphelocoma coerulescens coerulescens	T		T		L
Marian's marsh wren	Cistothorus palustris marianae	SC	SC			
Cape Sable seaside sparrow	Ammodramus maritima mirabilis	E	E	E		
MAMMALS						
Mangrove fox squirrel	Sciurus niger avicennia	E		T		
Sherman's fox squirrel	Sciurus niger shermani	T		SC		
Silver rice rat	Oryzomys argentatus	E	UR	E		
Florida mouse	Peromyscus floridanus	T		T		

(continued)

Table 1. Concluded.

Vertebrate taxon		Sources and status[a]				
Common name	Scientific name	FCREPA	FWS	GFWFC	CITES	NAS
Key Largo cotton mouse	Peromyscus gossypinus allapaticola	E	UR	E		
Key Largo woodrat	Neotoma floridana smalli	E	UR	E		
Florida black bear	Ursus americanus floridanus	T		T		
Key Vaca raccoon	Procyon lotor auspicatus	T		T		
Everglades mink	Mustela vison evergladensis	T		T		
River otter	Lutra canadensis		UR		II	
Florida panther	Felis concolor coryi	E	E	E	I	
Bobcat	Felis rufus		UR		II	
West Indian manatee	Trichechus manatus	T	E	E	I	
Key deer	Odocoileus virginianus clavium	E	E	T		

[a]FCREPA - Florida Committee on Rare and Endangered Plants and Animals (Pritchard 1978).
FWS - U.S. Fish and Wildlife Service.
GFWFC - Game and Fresh Water Fish Commission of Florida, Florida Wildlife, July-August 1981.
CITES - Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES 1976).
NAS - National Audubon Society American Birds Blue List 1980 (Arbib 1979; only birds not listed as Endangered by FWS).
E = Endangered, T = Threatened, SC = Special Concern, R = Rare, UR = Under Review, L = Listed, I and II = Appendix Number.

HABITATS OF SOUTHWEST FLORIDA

The physiography and climate of southwest Florida, which dictate its habitats, can be summarized briefly as low lying and subtropical.

Physiography

Southwest Florida has a low elevation with little topographic relief. Elevations range from sea level to only about 30 m (100 ft). Of the five physiographic regions recognized by Cooke (1939), one predominates: the Coastal Lowlands. Coastal Lowlands are nearly level plains representing terraces formed during periods of higher sea level. The Central Highlands is the only other region of Cooke (1939) occurring in southwest Florida; it forms the eastern edge of Hillsborough County and the northeast corner of Manatee County. Elevations within the Central Highlands are as low as 12 m (40 ft) in the valleys. The general line of demarcation, however, between the Central Highlands and Coastal Lowlands is the 100-ft contour.

Climate

Southwest Florida has warm, humid summers and mild, relatively dry winters. Mean air temperatures vary from 27.8°C (82°F) (Tampa) to 28.3°C (83°F) (Key West) in summer, and 16.7°C (62°F) (Tampa) to 21.1°C (70°F) (Key West) in winter. Summer temperatures vary little from day to day. Winter daily temperatures vary considerably, especially when cold fronts extend far down peninsular Florida. Infrequent cold fronts may cause air temperatures to drop below freezing at night, but they usually rise above freezing during the day (Jordan 1973) and subside in a few days. Minimum temperatures during cold nights vary extensively with locality, but are ameliorated by proximity to large bodies of water. Killing frosts occur annually in interior Florida, but not near the coast.

Rainfall in southwest Florida ranges annually from 131.1 to 138.9 cm (51.5 to 54.7 inches) on the mainland (Tampa, Fort Myers, Everglades) to 101.6 cm (40.0 inches) in Key West. Seasonal distribution is uneven, with over 60% of the rain falling from June through September. Mid-April through late May usually is the driest time of year (Jordan 1973). Summer rains occur mostly as brief showers; thunderstorms are frequent. Snow is essentially nonexistent; hail is rare. Rains in seasons other than summer tend to be more widespread, reflecting large-scale weather developments. Tropical storms, most common in summer or fall, tend to be accompanied by heavy rains and high winds.

Classification

The classification of habitats used in this study is that of the General Map of Natural Vegetation of Florida prepared by Davis (1967). The major advantages of this classification are that the map is complete for both wetlands and upland habitats, the entire study area has been mapped, and the classification is in wide use. Other classification systems consulted include those of the Florida Department of Administration (FDA 1976), the U.S. Department of Agriculture (1978), and those used by FCREPA (Pritchard 1978), Barnett et al. (1980), and, for wetlands only, Cowardin et al. (1979).

Table 2 lists Davis' (1967) classification and comparable habitat types from the FDA (1976) and Cowardin et al. (1979). Figure 2 is adapted from Davis (1967) and depicts the 13 terrestrial habitats that occur in the eight southwest counties composing the study area. Developed areas are not considered by Davis. Certain habitats of Davis do not occur in southwest Florida and their numbers are omitted on the figure. Two habitats were added to the 13 of Davis to represent habitats used by the vertebrates discussed in this report. The first is hammocks, which are geographically limited, but important to several endangered vertebrates; Davis listed this habitat as a subset of southern slash pine forest. The second habitat type is estuaries, which were not included in Davis' work.

The 13 terrestrial habitats of Davis (1967) are not distributed evenly among the eight counties. Upland habitats (e.g., longleaf pine/xerophytic oak) predominate to the north, and wetlands (e.g., open scrub cypress, wet to dry prairie marsh) and coastal habitats (e.g., mangrove) predominate to the south. This distribution is apparent in Table 3. The data presented in Table 3 were derived by tracing Figure 2 on fine tracing paper, cutting out the habitats, and weighing the pieces. This was done several times until consistent estimates of relative area were obtained. McCoy (1981) compared the results of this method to data derived from overlaying U.S. Geological Survey Land Use and Data Analysis (GS LUDA 1976) maps on Davis' (1967) habitat map of the study area, and determined that the cut-and-weigh method was an adequate means of analysis.

The following sections describe the key characteristics of each major terrestrial habitat type, and the listed vertebrates occurring in each type. The importance of each habitat to these vertebrates was based on relative animal densities in different habitats or frequency of habitat use. Some vertebrates have more than one preferred habitat, so multiple-listings occur. However, the greatest detail on ecology of a species is given under the first primary habitat (P) encountered in the sequence. Habitats used to a lesser extent by a taxon are listed as secondary (S). Wide-ranging species that live in many habitats are given the symbol (X). Table 4 summarizes these habitat-use designations and facilitates locating the principal habitat types under which each species is discussed in the following section. The numerical habitat codes of Davis (1967) are utilized in Table 4 and the following discussion, and are enclosed in parentheses.

DESCRIPTION OF HABITATS AND THEIR LISTED VERTEBRATE SPECIES

Coastal Strand (1)

Coastal strand is the strip of beach that extends from the high tide line of the gulf, landward to as far as vegetation is restricted to salt-tolerant halophytes. Bare sand occurs immediately adjacent to the gulf. A few meters farther inland the salt tolerant plant associations of the coastal strand occur. New islands of dredge material form an artificial example of coastal strand. Because these islands usually lie in quiet waters, their plant associations quickly succeed to other habitats. Both the seaward and landward

Table 2. Major Florida habitat types, in terms of areal extent, described by Davis (1967) and compared with classification systems of the Florida Department of Administration (FDA 1976) and the FWS (Cowardin et al. 1979). Numbers in parentheses are the FDA coding scheme. Habitats with * are not present in this study area.

Davis (1967)	FDA (1976)			FWS (Cowardin et al. 1979)
	Identical to Davis' categories	FDA category is a subset of Davis	Davis' category is a subset of FDA	
(1) Coastal strand		Coastal scrub (322)		Not described
(2) Pine flatwoods	Pine flatwoods (411)		Other (414)	Palustrine, forested wetlands, needle-leaved evergreen, temporary, saturated, seasonally flooded
(3) Southern slash pine forest			Other (414)	Not described
(4)* Mixed hardwood and pine forest		Mixed forest (431)	Other (414)	Not described
(5) Sand pine scrub forest	Sand pine scrub (413)			Not described
(6) Longleaf pine/ xerophytic oak forest	Longleaf pine (412)			Not described
(7) Cypress swamp	Cypress (611)			Palustrine, forested wetlands, needle-leaved deciduous, permanently flooded

(continued)

Table 2. (Continued).

Davis (1967)	FDA 1976)			FWS (Cowardin et al. 1979)
	Identical to Davis' categories	FDA category is a subset of Davis	Davis' category is a subset of FDA	
(8) Swamp forest		Pond pine (612), freshwater swamp (621), mixed forest (631)		Palustrine, forested wetland, broad-leaved evergreen, seasonally flooded
(9) Mangrove swamp and coastal marsh		Saltwater swamp (622), saltwater marsh (642)		Estuarine (intertidal), forested and scrub/shrub wetland, broad-leaved evergreen and estuarine intertidal), emergent wetland, persistent; regularly and irregularly flooded
(12)* Hardwood forest	Other hardwood (422)	Xeric oak (421)		Not described
(13) Prairie grassland		Grassland (310), palmetto prairie (321), other scrub (323), mixed rangeland (320)		Palustrine, emergent wetland, persistent, seasonally flooded
(14) Open scrub cypress			Other scrub (323)	Palustrine, scrub-shrub wetland, needle-leaved deciduous, seasonally flooded (to semipermanently flooded)

(continued)

Table 2. (Concluded).

Davis (1967)		FDA (1976)			FWS (Cowardin et al. 1979)
		Identical to Davis' categories	FDA category is a subset of Davis	Davis' category is a subset of FDA	
(15)*	Cabbage palm forest				Not described
(16)	Freshwater marsh			Freshwater marsh (641)	Palustrine, emergent wetland, persistent, semipermanently flooded
(16A)*	Everglades saw grass marsh			Freshwater marsh (641)	Palustrine, emergent wetland, persistent, seasonally flooded
(16B)	Everglades region marsh, slough, wet prairie, and tree islands			Freshwater marsh (641)	Palustrine, emergent wetland, persistent, seasonally flooded
(17)	Wet to dry prairie marsh on marl or rockland			Freshwater marsh (641)	Palustrine, emergent wetland, persistent, seasonally flooded

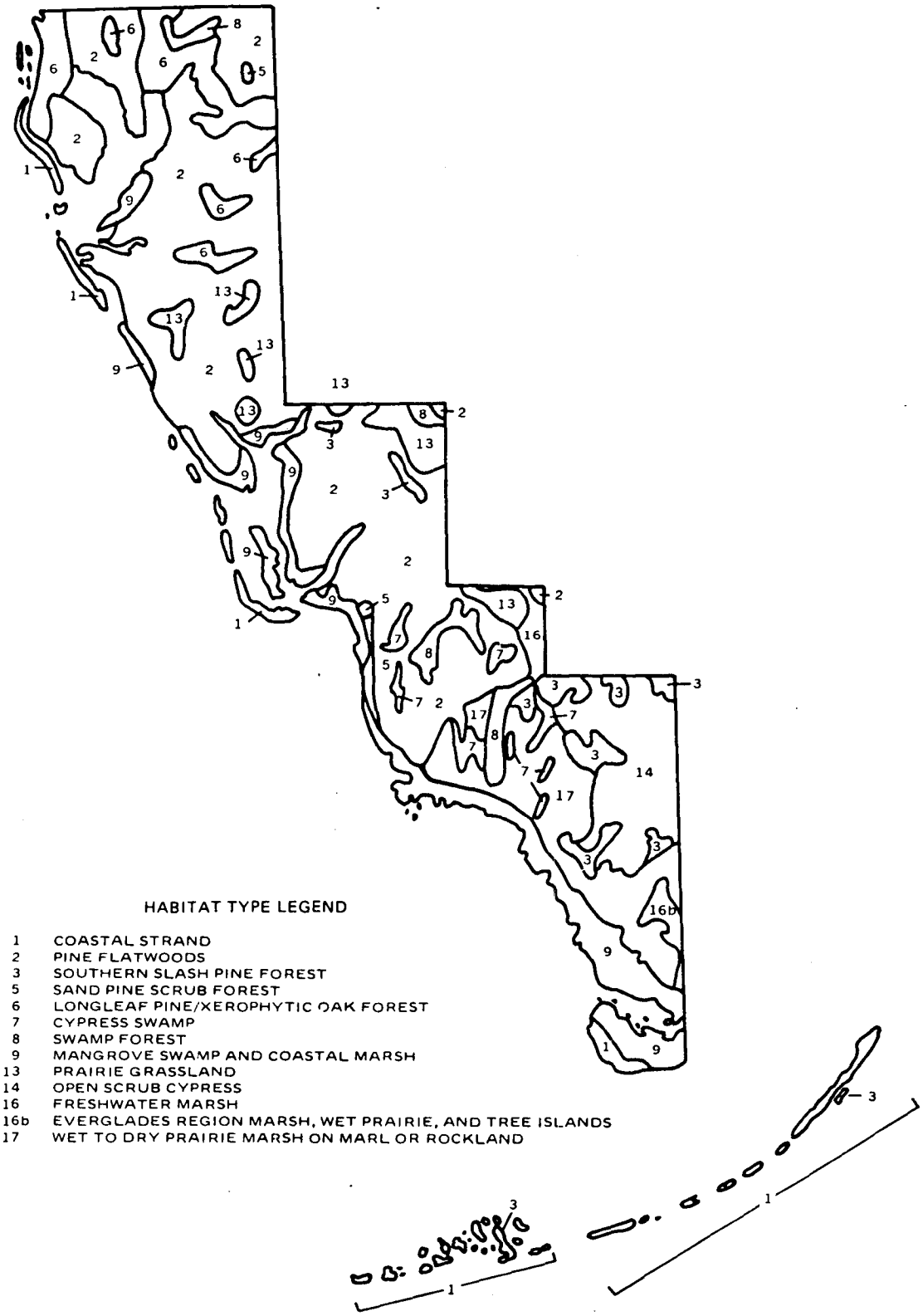

Figure 2. Distribution of 13 of Davis' (1967) habitats found in the eight-county study area.

Table 3. Percentage of each county covered by the 13 major habitats of Davis (1967).

Habitat type	County: Pinellas	Hillsborough	Manatee	Sarasota	Charlotte	Lee	Collier	Monroe	Total percent of study area
Coastal strand	15	1	2	3	2	3	-	2	2
Pine flatwoods	45	66	85	84	62	74	24	-	48
Southern slash pines	-	-	-	-	-	-	7	5	3
Sand pine scrub forest	-	1	-	-	2	2	2	-	1
Longleaf pine/xerophytic oak	40	26	8	-	-	-	-	-	6
Cypress swamp	-	-	-	-	2	3	7	4	3
Swamp forest	-	3	-	-	2	-	7	-	3
Mangrove swamp and coastal marsh	-	3	1	1	13	17	7	45	12
Prairie grassland	-	-	4	12	18	-	3	-	4
Open scrub cypress	-	-	-	-	-	-	23	10	8
Freshwater marsh	-	-	-	-	-	-	2	-	1
Everglades region marsh, slough, wet prairie, and tree islands	-	-	-	-	-	-	-	5	1
Wet to dry prairie marsh on marl or rockland	-	-	-	-	-	-	18	28	9

Table 4. Habitat-use designations of the listed vertebrate species of southwest Florida. * = Habitat type under which the taxon is discussed in greatest detail in the text; P = primary habitat; S = Secondary habitat; X = one of many habitats used by the species.

Vertebrate taxon	Habitat type[a]														
	Coastal strand (1)	Pine flatwoods (2)	S. slash pines (3)	Sand pine scrub (5)	Longleaf/oak (6)	Cypress swamp (7)	Swamp forest (8)	Mangrove/marsh (9)	Prairie grassland (13)	Scrub cypress (14)	Freshwater marsh (16)	Everglades (16B)	Marl/rock marsh (17)	Hammocks	Estuaries
FISHES															
Atlantic sturgeon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P*
Key silverside	-	-	-	-	-	-	-	P*	-	-	-	-	-	-	-
Rivulus	-	-	-	-	-	-	-	P*	-	-	-	-	-	-	-
Key blenny	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P*
AMPHIBIANS															
Gopher frog	-	S	-	P*	P	-	-	-	-	-	-	-	-	-	-
REPTILES															
American crocodile	-	-	-	-	-	-	-	P*	-	-	-	-	-	-	S
American alligator	-	-	-	-	-	S	-	S	-	-	P*	P	P	-	-
Leatherback sea turtle	X*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Green sea turtle	P*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hawksbill sea turtle	P*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kemp's Ridley sea turtle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	S*
Loggerhead sea turtle	P*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Key mud turtle	-	-	S	-	-	-	-	-	-	-	P*	-	-	-	-

(continued)

Table 4. Continued.

Vertebrate taxon	Habitat type[a]														
	Coastal strand (1)	Pine flatwoods (2)	S. slash pines (3)	Sand pine scrub (5)	Longleaf/oak (6)	Cypress swamp (7)	Swamp forest (8)	Mangrove/ marsh (9)	Prairie grassland (13)	Scrub cypress (14)	Freshwater marsh (16)	Everglades (16B)	Marl/rock marsh (17)	Hammocks	Estuaries
REPTILES															
Suwannee cooter	-	-	-	-	-	-	-	P*	-	-	-	-	-	-	-
Gopher tortoise	S	S	-	P*	P	-	-	-	-	-	-	-	-	-	-
Short-tailed snake	-	-	-	S	P*	-	-	-	-	-	-	-	-	-	-
Big Pine Key ringneck snake	-	-	P*	-	-	-	-	-	-	-	-	-	-	-	-
Red rat snake (Lower Keys)	-	-	P*	-	-	-	-	-	-	-	-	-	-	-	-
Florida brown snake (Lower Keys)	-	-	P*	-	-	-	-	-	-	-	-	-	-	-	-
Miami black-headed snake	-	-	P*	-	-	-	-	-	-	-	-	-	-	P	-
Eastern indigo snake	-	-	X*	X	X	X	X	-	-	X	-	-	-	X	-
Florida ribbon snake (Lower Keys)	-	-	-	-	-	-	-	P*	-	-	-	-	-	-	-
BIRDS															
Common loon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P*
Brown pelican	S	-	-	-	-	-	-	P*	-	-	-	-	-	-	P
Magnificent frigatebird	-	-	-	-	-	-	-	P*	-	-	-	-	-	-	-
Great white heron	-	-	-	-	-	-	-	P*	-	-	-	-	-	-	P
Little blue heron	-	-	-	-	-	P*	P	P	S	-	P	P	P	-	P
Reddish egret	S	-	-	-	-	-	-	P*	-	-	-	-	-	-	P

(continued)

Table 4. Continued.

Vertebrate taxon	Habitat type[a]															
	Coastal strand (1)	Pine flatwoods (2)	S. slash pines (3)	Sand pine scrub (5)	Longleaf/oak (6)	Cypress swamp (7)	Swamp forest (8)	Mangrove/marsh (9)	Prairie grassland (13)	Scrub cypress (14)	Freshwater marsh (16)	Everglades (16B)	Marl/rock marsh (17)	Hammocks	Estuaries
BIRDS															
Snowy egret	-	-	-	-	-	P*	P	P	S	-	P	P	P	-	P
Louisiana heron	-	-	-	-	-	P*	P	P	S	-	P	P	P	-	P
Least bittern	-	-	-	-	-	-	-	-	-	-	P*	P	P	-	-
American bittern	-	-	-	-	-	-	-	-	S	-	P*	P	P	-	-
Wood stork	-	-	-	-	-	P*	P	P	S	-	P	P	P	-	P
Roseate spoonbill	-	-	-	-	-	-	-	P*	-	-	-	P	P	-	P
Everglade kite	-	-	-	-	-	-	-	-	-	-	P*	P	P	-	-
Bald eagle	-	-	X	-	X	X	X	P*	X	-	-	X	X	-	-
Marsh hawk	-	-	-	-	-	-	-	P*	P	-	P	P	P	-	-
Audubon's caracara	-	-	-	-	-	-	-	-	P*	-	-	-	-	-	-
Peregrine falcon	X	-	-	-	-	-	-	X	X	-	-	-	-	-	P*
American kestrel	-	S*	S	-	P	-	-	-	S	-	-	-	-	-	-
Sandhill crane	-	-	-	-	-	-	-	-	P*	-	-	P	P	-	-
Limpkin	-	-	-	-	-	S	P*	-	-	-	-	-	-	-	-
American oystercatcher	P*	-	-	-	-	-	-	-	-	-	-	-	-	-	P
Piping plover	P*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Snowy plover	P*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Roseate tern	P*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Least tern	P*	-	-	-	-	-	-	-	-	-	-	-	-	-	P
White-crowned pigeon	-	-	-	-	-	-	-	P*	-	-	-	-	-	P	-
Burrowing owl	-	-	-	-	-	-	-	-	P*	-	-	-	-	-	-
Red-cockaded woodpecker	-	P	P	-	P*	-	-	-	-	-	-	-	-	-	-

(continued)

Table 4. Continued.

Vertebrate taxon	Habitat type[a]														
	Coastal strand (1)	Pine flatwoods (2)	S. slash pines (3)	Sand pine scrub (5)	Longleaf/oak (6)	Cypress swamp (7)	Swamp forest (8)	Mangrove/marsh (9)	Prairie grassland (13)	Scrub cypress (14)	Freshwater marsh (16)	Everglades (16B)	Marl/rock marsh (17)	Hammocks	Estuaries
BIRDS															
Ivory-billed woodpecker	-	-	-	-	P*	-	P	-	-	-	-	-	-	S	-
Florida scrub jay	-	-	-	P*	-	-	-	-	-	-	-	-	-	-	-
Marian's marsh wren	-	-	-	-	-	-	-	P*	-	-	-	-	-	-	-
Cape Sable seaside sparrow	-	-	-	-	-	-	-	-	-	-	-	P	P*	-	-
MAMMALS															
Mangrove fox squirrel	-	-	P*	-	-	-	-	-	-	S	-	-	-	-	-
Sherman's fox squirrel	-	S	-	-	P*	-	-	-	-	-	-	-	-	-	-
Silver rice rat	-	-	-	-	-	-	-	-	-	-	P*	-	-	-	-
Florida mouse	-	-	-	P*	P	-	-	-	-	-	-	-	-	-	-
Key Largo cotton mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	P*	-
Key Largo woodrat	-	-	-	-	-	-	-	-	-	-	-	-	-	P*	-
Florida black bear	X	-	X	X	X	X	X*	X	X	X	-	X	X	X	-
Key Vaca raccoon	-	-	-	-	-	-	-	P*	-	-	-	-	-	-	-
Everglades mink	-	-	-	-	-	-	S	-	-	-	P*	P	P	-	-
River otter	-	-	-	-	-	P*	P	-	-	-	-	-	-	-	-
Florida panther	X	X*	X	X	X	X	X	X	X	X	-	X	X	X	-
Bobcat	X	-	X	P*	X	X	X	X	X	X	-	X	X	-	-
West Indian manatee	-	-	P*	-	-	-	-	S	-	-	-	-	-	-	-

(continued)

Table 4. Concluded.

Vertebrate taxon	Habitat type[a]														
	Coastal strand (1)	Pine flatwoods (2)	S. slash pines (3)	Sand pine scrub (5)	Longleaf/oak (6)	Cypress swamp (7)	Swamp forest (8)	Mangrove/marsh (9)	Prairie grassland (13)	Scrub cypress (14)	Freshwater marsh (16)	Everglades (16B)	Marl/rock marsh (17)	Hammocks	Estuaries
Number listed of species that occur in habitat	16	6	14	9	13	12	13	25	15	5	12	17	17	8	17
Number of listed species for which habitat is of primary importance	8	1	7	5	8	5	8	19	4	0	12	13	13	4	15

[a]Numerical habitat codes of Davis (1967) are enclosed in parenthesis.

margins of coastal strand are prone to shifts of position in response to erosion and deposition by shore currents. Coastal strand covers less than 2% (132 mi^2) of the total area of the eight southwestern coastal Florida counties. It is most common in Pinellas County (Table 3).

Pioneer herbs and shrubs occur near shore; scrubby forest, farther inland. Typical plants in this habitat include Australian pine (Casuarina equisetifolia), a widespread exotic; Spanish bayonet (Yucca aloifolia); beach elder (Iva imbricata); sea oats (Uniola paniculata); railroad vine (Ipomoea pescaprae); beach morning glory (Ipomoea stolonifera); sea grape (Coccoloba uvifera); salt bush (Baccharis halimifolia); wax myrtle (Myrica cerifera); cacti (Opuntia spp.); and a variety of grasses. Although Davis (1967) classified most of the Florida Keys as coastal strand, they are predominately mangrove swamp (3) and hardwood hammock, as shown in Figure 2.

Listed vertebrates of the coastal strand. Coastal strand is habitat for 16 of the 68 vertebrate taxa. It is primary habitat (P) for eight, and secondary (S) or one of many habitats used (X) for eight others. Four of the five listed sea turtles are in one or another of these categories. The fifth turtle, the Kemp's Ridley, is also discussed here. The list is as follows:

P	Green sea turtle	S	Gopher tortoise
P	Hawksbill sea turtle	S	Brown pelican
P	Loggerhead sea turtle	S	Reddish egret
P	American oystercatcher		
P	Piping plover	X	Leatherback sea turtle
P	Snowy plover	X	Peregrine falcon
P	Roseate tern	X	Florida black bear
P	Least tern	X	Florida panther
		X	Bobcat

Five sea turtle species occur in the waters off southwest Florida: the leatherback, green, hawksbill, Kemp's Ridley, and loggerhead. Female sea turtles come to dry land only to nest, and males, never at all. Only one species, the loggerhead, now commonly nests in Florida. The hawksbill and green turtles nest occasionally in Florida; the leatherback, rarely. The Kemp's Ridley is not known to nest in Florida.

Because the open gulf is beyond the scope of this report, coastal strand is considered the primary terrestrial habitat for nesting sea turtles; therefore the entire group of five species is treated here. The primary information sources are Lund (1974) and a National Fish and Wildlife Laboratory (no date) draft report.

The loggerhead sea turtle nesting population in Florida is estimated at 20,000 to 21,000, but nearly all nesting is on the Atlantic coast of Florida, outside the study area. Young hawksbills have been seen in the Keys, and in 1980 one nest was found on Longboat Key. The green sea turtle, once widespread in Florida but now rare, nests primarily along the southeast coast; however, it may nest occasionally in southwest Florida. Only 10 to 12 leatherbacks nest annually in Florida, also outside of the study area; however, evidence suggesting nesting along the Florida panhandle indicates a potential

for nesting along the gulf coast of Florida. Kemp's Ridley adults apparently nest only along a small segment of the coast of Mexico; however, young and subadults inhabit shallow estuarine waters of both the Gulf of Mexico and Atlantic coast of the United States.

The two most serious threats to the continued existence of sea turtles are the destruction of nests and nesting beaches (mostly elsewhere in the world) and the accidental or intentional killing of turtles at sea. Shrimp trawls in the Gulf of Mexico kill many turtles. Various other kinds of encounters with boats also kill sea turtles.

The southwest Florida coast has extensive areas of coastal strand, including localities under preservation (Everglades National Park, Dry Tortugas, certain parts of the Florida Keys). Restoration of former nesting sites and establishment of new nesting sites are being attempted and plans are being made to expand the program. Sites in southwest Florida, especially Monroe County, could be important to these programs.

Five of the listed birds are virtually restricted to coastal strand. Two reside there all year: the American oystercatcher (DeGange 1978) and snowy plover (Woolfenden 1978a). The roseate and least terns are summer residents (Fisk 1978; Robertson 1978c). These four breeding species lay their eggs on the open strand. The piping plover, a winter resident only, breeds north of Florida (Woolfenden 1978c). The oystercatcher feeds on mollusks and arthropods found in shallow-water habitats bordering the coastal strand. Piping and snowy plovers feed here too, and also on the open strand above the high tide line; they feed on small arthropods. Roseate and least terns feed on small fish taken from shallow waters near their nesting colonies.

Recently, manmade spoil islands have proven to be acceptable artificial habitat for all five of the aforementioned birds. In addition, flat roofs of buildings are used for nesting by least terns; however, the success of their breeding on rooftops has been questioned and needs investigation (Fisk 1978).

Nesting by the roseate tern in Florida is confined to Monroe County, specifically the Keys and the Dry Tortugas. The total population is about 300 birds. Although the data are inadequate, the roseate tern may be no scarcer in Florida now than in the past; and the colonies, which often may be unsuccessful at producing young, may be maintained by recruitment from successful colonies in the Bahamas (Robertson 1978c). The outlook for roseate terns on the Atlantic coast of North America is bleak; populations have declined drastically (Erwin 1979).

Several habitats, including coastal strands, are important for the existence of brown pelicans, reddish egrets, peregrine falcons, and gopher tortoises. Pelicans use the coastal strand, especially islands and remote spits, for loafing and preening; they are discussed under mangrove habitat. Reddish egrets, and to some extent peregrine falcons, forage along the coastal strand. The egret is discussed further under mangrove habitat; the peregrine, under estuaries. Gopher tortoises need well-drained sandy soil. They live in several habitats in Florida, including the coastal strand. Perhaps because of limited access, gopher tortoises are less common in coastal strand than in other habitats. The species is discussed under sand pine scrub.

The Florida black bear, Florida panther, and bobcat are the top carnivores in Florida. As predators, they roam widely. Florida black bears appear to prefer swamp forests, and the species is discussed under that habitat. No preferred habitat has been determined for the panther. Because its preferred food is deer (Williams 1978a), the Florida panther is discussed under pine flatwoods, which are frequented by deer. Bobcats seem to prefer sand pine scrub forest (Guenter; personal communication), and are discussed there.

Pine Flatwoods (2)

The pine flatwoods are dominated by medium-sized pines too widely spaced to form a continuous canopy. Beneath the scattered pines grows a sparse understory of low shrubs and grasses. The substrate is level sandy soil, deposited during geologically recent periods of high sea level. Beneath the organic layers lies an acid hardpan, which reduces percolation of rainfall, upwelling of ground water, and root penetration. These conditions limit the total flora of the pine flatwoods and result in a patchy distribution of the plants that are present.

The dominant plants of an area are determined by drainage. On better-drained sites, longleaf pine (Pinus palustris) dominates; on intermediate sites, slash pine (Pinus elliottii); and on the wettest sites, pond pine (Pinus serotina), a species not found in the study area. Beneath the longleaf pines grows a sparse understory of wiregrass (Aristida stricta), and runner oak (Quercus pumila). In slash pine stands grow gallberry (Ilex glabra) and saw palmetto (Serenoa repens). At the wettest sites, with the pond pines, grow rusty lyonia (Lyonia ferruginea) and swamp bay (Persea palustris). At the lowest and wettest sites within the widespread pine flatwoods habitat are intermingled cypress domes (7) and bayheads (8).

Periodic burning is essential to maintain the pine flatwoods. If fire is excluded from this natural disclimax, oaks and other hardwoods will take over. Originally, about 48% (3437 mi^2) of the total land surface of the eight southwest Florida counties was pine flatwoods.

Listed vertebrates of the pine flatwoods. Few of the 68 listed species of vertebrates use pine flatwoods as their primary habitat. This habitat may be more important than a simple survey reveals, however, because of the vast areas occupied by pine flatwoods (48% of the total) and because several of the scarce, scattered habitats (e.g., freshwater marshes, hammocks) lie within pine flatwoods.

Pine flatwoods are primary habitat for only one vertebrate, the red-cockaded woodpecker. They are important habitat for the wide-ranging Florida panther, and of secondary importance for four others:

P	Red-cockaded woodpecker	S	American kestrel
S	Gopher frog	S	Sherman's fox squirrel
S	Gopher tortoise	X	Florida panther

The red-cockaded woodpecker lives only among mature or overmature stands of pines. As with the Florida scrub jay, this woodpecker is a communal

breeder, and family units occupy the same large territories for many years. Nest and roosting cavities are dug into living trees infected with fungus (Baker 1978). Greatly diminished numbers of mature and diseased trees have reduced red-cockaded woodpecker populations to dangerously low levels.

In Florida, the size of panther populations is closely linked with deer populations. Thus pine flatwoods habitat is important to panthers because this habitat supports deer (Williams 1978a) and more recently feral hogs (Sus scrofa), another important food source. Pine flatwoods also are important to this top carnivore because individuals must roam extensively to feed and breed, and pine flatwoods usually form the corridors between various other habitat types.

Data are few and opinions vary on the number of panthers remaining in Florida. McCauley (1977) estimated 100 to 200; Shapiro (1981) estimated probably fewer than 50. The frequency of encounters by humans tends to support the higher figure. Regardless, southwest Florida must be extremely important to panthers because their concentrations appear to be in Everglades National Park (Dade and Monroe Counties), Myakka River Valley (Sarasota and Manatee Counties), the Fakahatchee Strand (Collier County), and Gulf Hammock to the north of the study area.

The four vertebrates for which pine flatwoods are secondary habitat are more abundant in forests of large pines, which are on higher, drier soil. Gopher frogs and gopher tortoises occur in the better-drained portions of pine flatwoods and American kestrels and Sherman's fox squirrels maintain populations in patches of large pines.

Southern Slash Pine Forest (3)

Southern slash pine forest has an overstory of medium-sized pines that form a discontinuous canopy. Density of the understory varies inversely with the density of the pine canopy. Where this canopy is thickest, the understory is a thicket of tall spindly shrubs. The substrate usually is a thin layer of soil overlying limestone. Sometimes this habitat occurs on sand flats, which drain better than the limerock. Because of their poor drainage, the southern slash pine forests on the limerock in Collier and Monroe Counties have been altered less for agriculture than the forests in Dade County, where the substrate tends to be sandy.

The southern slash pine (Pinus elliottii var. densa) is the dominant canopy tree. The understory includes bustic (Dipholis salicifolia), poisonwood (Metopium toxiferum), cabbage palm (Sabal palmetto), silver palm (Coccothrinax argentata), and various grasses. Periodic fires maintain the pine overstory by removing competing hardwoods. In the eight southwest Florida counties, this habitat is restricted to Collier and Monroe Counties. It accounts for less than 3% (192 mi^2) of the land area.

Listed vertebrates of southern slash pine forests. Southern slash pine forests are prime habitat for seven vertebrates, and secondary, or one of many habitats used, for seven others.

P	Big Pine Key ringneck snake	S	Key mud turtle
P	Red rat snake	S	American kestrel
P	Florida brown snake		
P	Miami black-headed snake	X	Eastern indigo snake
P	Mangrove fox squirrel	X	Bald eagle
P	Key deer	X	Florida black bear
P	Red-cockaded woodpecker	X	Florida panther
		X	Bobcat

Southern slash pine forests form the principal native vegetation on many of the Florida Keys. Several distinct island populations of vertebrates have developed in the southern slash pine forests of the Keys. The Big Pine Key ringneck snake, red rat snake, and Florida brown snake on Big Pine Key and nearby islands show varying degrees of differentiation from mainland populations (Weaver 1978b). The Miami black-headed snake is endemic to southeast Dade County and nearby islands in Monroe County (Campbell 1978b). Although these reptiles are poorly studied, the local pine forests appear to be the primary habitat for these small populations. The Key deer, restricted to the vicinity of Big Pine Key, uses pinelands and also grassy roadsides and other clearings created by humans (Klimstra and Hardin 1978). The Key mud turtle, though primarily aquatic, traverses pinelands when moving between small bodies of water (Weaver 1978a).

On the mainland, southern slash pine forest is primary habitat for the mangrove fox squirrel, despite its common name. Its present range is mostly in Collier and Lee Counties, but it also occurs in adjacent Hendry and Monroe Counties (Brown 1978a). Slash pine seeds are an important food for these squirrels. The population is intolerant of human encroachment, and thus disappears as forests are segmented.

Southern slash pine forests are secondary habitat for American kestrels, present in some stands of large pines. Bald eagles and the top mammalian predators (bear, panther, and bobcat) also occur in this habitat.

Eastern indigo snakes use many habitats and individuals roam widely. They have a broad diet, preying on small mammals and birds as well as frogs, lizards, and snakes, including venomous species (Kochman 1978).

Sand Pine Scrub Forest(5)

This habitat consists of numerous low-growing oaks and scattered sand pines. It occurs on the rolling topography of relict dunes formed during the Pliocene (Laessle 1958). The dunes are deep, well-drained, acid, sandy soils of the St. Lucie and Lakewood series. Periodic fires retard development of dense stands of pines. This scrub is the most distinct habitat in Florida, and may be one of the rarest habitats in North America.

The scattered sand pines (Pinus clausa) are dispersed among a thick but clumped understory of scrub oaks (Quercus inopina), live oaks (Q. virginiana), Chapman oaks (Q. chapmanii), rosemary (Ceratiola ericoides), sand palmetto (Sabal etonia), saw palmetto (Serenoa repens), and various scrubby hardwoods

and grasses. This relict habitat is uncommon in southwest Florida, and occupies only 1% (80 mi^2) of the total land surface, mostly in Charlotte, Lee, and Collier Counties. Major patches of this habitat occur to the east of the study area on the central ridge of Florida.

Listed Vertebrates of sand pine scrub forests. Five of the vertebrates listed use sand pine scrub forest as their primary habitat. It is of lesser importance to four others:

P	Gopher frog	S	Short-tailed snake
P	Gopher tortoise		
P	Florida scrub jay	X	Eastern indigo snake
P	Florida mouse	X	Florida black bear
P	Bobcat	X	Florida panther

The sand pine scrub supports dense populations of gopher tortoises because the well-drained sand allows for extensive tunnels and the vegetation includes many low-growing succulents used as food (Auffenberg 1978b). The gopher frog uses the tortoise burrows, so it too is a common inhabitant of the scrub (Fogarty 1978). No vertebrate listed is more restricted to the scrub than the Florida scrub jay. A communal breeder, its family units occupy large permanent territories (about 25 acres). Acorns are the only important plant food for the jays. Insects and small vertebrates make up the remainder of the diet (Woolfenden 1978b). The Florida mouse has a similar narrow tolerance of habitat variation, and its primary habitat is the early successional stages of sand pine scrub (Layne 1978). Coastal scrubs at the north end of the study area are occupied by both the jay and the mouse; the jay also inhabits some of the isolated patches of scrub south to Collier County. The bobcat is a top carnivore in many habitats; however, the scrub may be where it reaches peak densities (Guenther 1980). Rabbits (Sylvilagus spp.) abundant in the numerous grasses and herbs of the sand pine scrub, are the staple diet of bobcats in the area.

Though more common in the sandhill community, the short-tailed snake occurs in some patches of scrub. The eastern indigo snake, bear, and panther also use sand pine scrub habitat.

Longleaf Pine/Xerophytic Oak Forest (6)

Often referred to as the sandhill community, this habitat is characterized by tall, large longleaf pines (Pinus palustris) with low shrubs and grasses growing in the ample space between them. The topography is gentle rolling uplands of well-drained yellowish sands. The sands contain more organic material than those of the sand pine scrub forest, and usually are many feet deep. The pine overstory is maintained through the elimination of the understory by fire. Wiregrasses (Aristida spp.) are an excellent fuel for fires and retard hardwood germination and growth. Where fires are excluded, turkey oak (Quercus laevis) and bluejack oak (Q. incana) enter the canopy. The common understory plants are largely herbaceous and include, in addition to wiregrasses, beggar's tick (Bidens pilosa), partridge pea (Cassia fasciculata), milk peas (Galactia spp.), and gopher apple (Licania michauxii). About 6% (435 mi^2) of the study area is occupied by longleaf pine/xerophytic oak

forest, mostly in the northern three counties. Few old, large longleaf pines remain, most having been cut for lumber.

Listed vertebrates of longleaf pine/xerophytic oak forests. The well-drained sands and large pines of this habitat type are home for numerous endangered vertebrates. It is primary habitat for eight species and often is used by five other species:

P	Gopher frog	X	Eastern indigo snake
P	Gopher tortoise	X	Bald eagle
P	Short-tailed snake	X	Florida black bear
P	American kestrel	X	Florida panther
P	Red-cockaded woodpecker	X	Bobcat
P	Ivory-billed woodpecker		
P	Sherman's fox squirrel		
P	Florida mouse		

The gopher frog, gopher tortoise, and Florida mouse are burrowers. The well-drained sands of both the sand pine scrub and longleaf pine forests are optimum burrowing substrates. These three species were discussed under the preceding habitat, the sand pine scrub forest (5). The short-tailed snake, another burrower, appears to be more common in the yellow sands of longleaf pine habitat than the sand pine habitat (Campbell 1978a). This snake is endemic to Florida, and has extremely narrow habitat tolerances. Its life history and ecology are little known. Because the short-tailed snake is unique, it is of great biosystematic interest to herpetologists.

The large, well-spaced longleaf pines are habitat for the American kestrel, red-cockaded woodpecker, and Sherman's fox squirrel. The American kestrel, a small falcon, feeds on large insects and small vertebrates taken in open areas, including open forests. The species nests in the cavities of large trees. The Florida race of the species, Falco sparverius paulus, seems to be declining (Wiley 1978). Unpublished studies by D.W. Johnston (pers. comm., George Mason Univ., Fairfax, VA) suggest that reduction in large dead trees may account for the decline of breeding kestrels in Florida.

Most literature describes the ivory-billed woodpecker as inhabiting hardwood forests. However, L.L. Short (pers. comm., American Museum of Natural History, New York, NY), a world authority on woodpeckers, questions this opinion. He suggests that longleaf pine forests may have been their primary habitat in the Southeast United States. A valid sighting was made in south-central Florida in the 1960's (A. Wetmore, pers. comm., deceased, National Museum of Natural History, Washington, DC), but probably this magnificent bird not only is extirpated from Florida, but from the entire United States (Hardy 1978).

Sherman's fox squirrel also prefers longleaf pines, and accordingly is found only in the northern tier of counties of the study area. Pine seeds and acorns from the xeric oak understory are the bulk of its diet. Loss of mature pine stands has caused their decline (Ehrhart 1978).

Five wide-ranging carnivores inhabit longleaf pine/xerophytic oak forest: the indigo snake, the panther, and bobcat discussed above; and the bald eagle and black bear, to be discussed below.

Cypress Swamp (7)

Cypress trees, often large and densely packed, dominate these wetlands. Patches of medium-sized hardwoods are scattered among the cypress. Standing water overlies the sandy substrate of this habitat. Cypress swamps occur bordering lakes and rivers, and in depressions in other habitat types. The small patches occupying wet depressions, especially in pine flatwoods and prairies, are known as cypress domes because the cypress trees are progressively larger toward the center of the depression, resulting in a hemispherical canopy. In most areas the huge cypress trees have been removed for lumber.

Bald cypress (Taxodium distichum) dominates the canopy of wet shorelines, while pond cypress (T. distichum nutans) predominates in cypress domes. The saturated substrate and fires prevent succession to broadleaf evergreen forests called bayheads.

Black gum (Nyssa sylvatica), red maple (Acer rubrum), sweetbay (Magnolia virginiana), wax myrtle (Myrica cerifera), water ash (Fraxinus caroliniana), willow (Salix caroliniana), and various ferns and epiphytes are common understory plants. Standing water in the swamps supports arrowhead (Thalia geniculata), pickerel weed (Pontederia lanceolata), sawgrass (Cladium jamaicensis), and other openwater plants. Cypress swamps occupy about 3% (219 mi^2) of the total land in the study area, and are concentrated in the southern counties.

Listed vertebrates of cypress swamps. Vertebrate species that inhabit cypress swamps are listed below:

P	Little blue heron	S	American alligator
P	Snowy egret	X	Eastern indigo snake
P	Louisiana heron	X	Bald eagle
P	Wood stork	X	Florida black bear
P	River otter	X	Florida panther
S	Limpkin	X	Bobcat

Nine of the 32 birds listed in Table 1 are long-legged waders (herons, egrets, bitterns, stork, spoonbill, crane, limpkin). All nine require wetlands. Most prefer open prairie wetlands, but some also inhabit swamps, which are forested wetlands.

The little blue heron, snowy egret, and Louisiana heron are medium-sized waders that feed extensively in cypress swamps. Their diets consist of small aquatic vertebrates, such as fishes, frogs, and aquatic invertebrates (Ogden 1978c). Wood storks have a similar diet, though they tend to select larger prey. Wood storks are highly specialized feeders and roam over large areas to feed on concentrations of fish and amphibians. Recently flooded wetlands and water remaining after floodwaters recede are preferred feeding areas (Ogden 1978a). These four aquatic feeders, and several other heron species that are not designated as listed species, often establish nesting colonies in cypress

swamp trees. The river otter, a mammalian carnivore specialized for aquatic feeding, frequents several wetland habitats, but prefers swamps (Layne 1974).

The limpkin and American alligator frequent cypress swamps, but prefer other types of wetlands and are discussed later. Cypress swamps are difficult for man to traverse by foot or vehicle. Possibly for this reason the habitat is a haven for several of the top predators, namely the bear, panther, and bobcat. In south Florida, the Big Cypress Swamp in Collier County seems to contain the largest populations of all three of these large carnivores (Layne 1974). The Myakka River area in Sarasota and Manatee Counties also may be important (Williams 1978a, b). Recent data (J. Layne, pers. comm., Archibald Biological Station, Lake Placid, FL) indicate that indigo snakes have large home ranges. Bald eagles use cypress swamps to feed on heron nestlings or to nest in tall trees, but are more common in other habitats (Robertson 1978b).

Swamp Forest (8)

Swamp forest is often aptly called floodplain forest because this habitat type is dominated by a variety of flood-tolerant hardwoods. Shading and flooding nearly eliminate ground cover. Swamp forests border river basins and grow on a substrate that is flooded, or at least saturated, for about 6 months each year from May to October. Small stands may be dome shaped, while more extensive tracts are forest-like. In south Florida small patches are replaced by hammocks as the solution holes fill with debris.

The dense, closed canopy of the wettest portions are dominated by black gum (Nyssa sylvatica), with scattered cypress. Slightly drier areas support red maple (Acer rubrum), water oak (Quercus nigra), sweetgum (Liquidambar styraciflua), water ash (Fraxinus caroliniana), and water hickory (Carya aquatica). Swamp forest often intergrades with mesic forest. The shaded interior supports dahoon holly (Ilex cassine), buttonbush (Cephalanthus occidentalis), willow (Salix caroliniana), and numerous orchids and bromeliads. The sparse ground cover includes patches of sawgrass (Cladium jamaicensis) and bracken fern (Pteridium aquilinum).

An important subtype of the swamp forest is the bayhead, a broadleaf evergreen forest found on acidic peat soils where water levels are relatively stable. Three distantly related trees with similar morphology are dominant: red bay (Persea borbonia), sweet bay (Magnolia virginiana), and loblolly bay (Gordonia lasiantha).

Swamp forest habitat makes up less than 3% (227 mi^2) of the total study area and is scattered through Hillsborough County, along the Hillsborough River, and through Charlotte and Collier Counties.

Listed vertebrates of swamp forests. These hardwood forests provide optimum living conditions for eight endangered vertebrate species, secondary habitat for one, and are used regularly by four wide-ranging species.

P	Little blue heron	S	Everglades mink
P	Snowy egret		
P	Louisiana Heron	X	Eastern indigo snake
P	Wood stork	X	Bald eagle
P	Limpkin	X	Florida panther
P	Ivory-billed woodpecker	X	Bobcat
P	Florida black bear		
P	River otter		

Wooded swamp, be it cypress or hardwood, is excellent habitat for the little blue heron, snowy egret, Louisiana heron, and wood stork. These long-legged waders were discussed under cypress swamp. The extensive riverbottom swamp forests are primary habitat for the limpkin, a unique bird with a specialized diet. The limpkin, the lone member of the family Aramidae, specializes in eating apple snails (Pomacea) and other large mollusks, with a minor supplement of larger aquatic animals. The limpkin is an obligate swamp inhabitant, whose population has declined through the last several decades (Nesbitt 1978).

Most literature lists the ivory-billed woodpecker as a lowland, hardwood forest inhabitant (Hardy 1978), but this is questioned by L.L. Short (see long-leaf pine above). Regardless of which forest habitat was primary for the species, the cutting of large trees and segmenting of forests account for the decline and probable elimination of this magnificent bird, not only from Florida, but from the United States.

The Florida black bear sometimes takes large prey, including feral hogs and cattle, but it has a broad diet including a wide variety of plant foods such as acorns, and cabbage palm buds (Williams 1978b). The black bear prefers dense cover throughout its range and in south Florida favors bayhead swamps (Williams 1978b), a subtype of swamp forest habitat. Big Cypress Swamp and Myakka River State Park harbor virtually all of the bears that remain in southwest Florida. The total bear population in southern Florida is estimated at 100 (Layne 1974).

The river otter, a swamp inhabitant, is common in swamp forest as well as cypress swamp. It was discussed with the latter habitat. Swamp forest, partly because of its limited accessibility to humans, harbors several of the other wide-ranging carnivores (see list above).

Mangrove swamp and coastal marsh (9)

Mangrove swamps are coastal forests consisting of one to three species of trees: black mangroves (Avicennia germinans), red mangroves (Rhizophora mangle), and white mangroves (Laguncularia racemosa). Red mangroves form dense forests with nearly impenetrable tangles of prop roots. In contrast, black mangroves can occur as a forest of large, widely spaced trees with a carpet of low-growing halophytes.

Coastal marshes consist of dense to open stands of grasses and Juncus. Patches of low vegetation are interspersed among extensive stands of chest-high plants. These marshes grow along low-energy shorelines, especially ir estuaries and upstream in tidal rivers.

The boundaries between these two saline communities shift rapidly with subtle changes in the environment. Peat and quartz sands underlie the mangroves; shell and muck underlie the marshes. Tidal regimes are a critical regulating factor for several reasons: (1) nutrient-rich detritus washes in and out of these communities, (2) salt tolerance and dessication vary widely and promote conspicuous patterns of zonation, and (3) the low tidal amplitude along the gulf coast of Florida results in the formation of irregularly flooded black mangrove/saltwort flats and glasswort salt pans.

Common plants in mangrove swamps, in addition to the three mangrove species, are saltwort (Batis maritima) and glasswort (Salicornia spp.). Coastal marshes are dominated by cordgrasses (Spartina spp.), black rush (Juncus roemerianus), and saltgrass (Distichlis spicata).

Mangrove swamps and coastal marshes often intergrade with freshwater marshes landward. Mangroves cannot withstand prolonged cold. In the absence of freezing temperatures, mangrove trees can outcompete coastal marsh vegetation. Coastal marshes are not as extensive in southwest Florida as farther north along the gulf coast of the State, probably because of the warmer winters from Tampa Bay southward. Mangrove swamp and coastal marsh cover 12% (842 mi^2) of the study area and are especially abundant in Monroe County.

Listed vertebrates of mangrove swamps and coastal marshes. The mangrove swamp and coastal marsh association is primary habitat for more rare and endangered vertebrates (19) in southwest Florida than any of the other 15 habitats. For six other vertebrates the mangrove-marsh habitat is either secondary in importance or one of many haibtats used by wide-ranging species.

P	Key silverside	P	Snowy egret
P	Rivulus	P	Louisiana heron
P	American crocodile	P	Wood stork
P	Suwanee cooter	P	Roseate spoonbill
P	Florida ribbon snake	P	Bald eagle
P	Brown pelican	P	Marsh hawk
P	Magnificent frigatebird	P	White-crowned pigeon
P	Great white heron	P	Marian's marsh wren
P	Little blue heron	P	Key Vaca raccoon
P	Reddish egret		
		X	Peregrine falcon
S	American alligator	X	Florida black bear
S	Key deer	X	Florida panther
		X	Bobcat

Mangrove forest is important wildlife habitat for several general reasons. The tall trees and dense vegetation provide a haven for numerous species, particularly colonial, tree nesting birds. The nutrient- and detritus-rich waters establish a base for complex food chains in the waters within the forest, and in the marshes and estuaries nearby.

Vegetated, shallow coastal waters are primary habitat for two of the four endangered fishes, the Key silverside and rivulus. The silverside is a Lowen

Keys endemic; the rivulus, a West Indian species, is more widespread in that it extends northward along the southern third of the Florida peninsula (Gilbert 1978a; Snelson 1978).

The American crocodile has only a tenuous hold in North America, being confined to the upper Keys and coastal areas in Monroe, Collier, and Dade Counties. The total population is between 100 and 400 individuals, with only about 20 breeding females (Ogden 1978d; Shapiro 1980). Within the study area, the Swannee cooter is known only from the Hillsborough and Alafia Rivers in Hillsborough County. This turtle tolerates salt water, and probably occurs in the marshes at the mouths of these rivers. Humans in pleasure boats probably have caused the drastic decline in numbers (Auffenberg 1978a). The Lower Keys population of the ribbon snake is found in both mangroves and marshes, as well as along those bodies of freshwater that remain in the Lower Keys. The restricted range of the Lower Keys population, which occurs only on Big Pine, Cudjoe, and No Name Keys, makes this vertebrate susceptible to elimination (Weaver 1978c).

Most of the colonial waterbirds of southwest Florida nest in mangroves. This includes the nine endangered birds in the list above from brown pelican through roseate spoonbill. Brown pelicans in Florida include about 8,000 pairs, and probably more than half reside along the southwest coast. They feed in estuaries and nearshore gulf waters, and nest at numerous localities along the mainland and in the Keys. Pelicans use coastal strand islands and spits for loafing and preening (Schreiber 1978).

Frigatebirds roost at numerous localities along the coast of southwest Florida, but rest only at the Marquesas Keys in Monroe County. Favored roosting places in the study area include Tampa Bay, Charlotte Harbor, Ten Thousand Islands, and Florida Bay. In the summer each of these localities has several hundred to a few thousand frigatebirds. Often they roost where other mangrove-nesting birds are breeding. Small islands of red mangroves are the preferred roosting habitat (Robertson 1978a).

Of the seven long-legged waders that need mangrove habitat to exist in southwest Florida, three are primarily coastal: the great white heron, reddish egret, and roseate spoonbill. Mangroves are extremely important for nesting and/or feeding to populations of the other long-legged waders: the little blue heron, snowy egret, Louisiana heron, and wood stork. These four species also have large populations in interior freshwater habitats, which were discussed previously (see cypress swamp). The white color morph of the great blue heron species, herein referred to as the great white heron, is an open-area, coastal inhabitant. This habitat preference alone indicates significant behavioral differences between the white and the more widespread blue morph. The current breeding range of the great white heron is confined to Florida Bay in Monroe County. Only a few stray from this area during the nonbreeding season. The total population is about 2,000 adults (Robertson 1978e).

The reddish egret also is almost entirely a coastal species, nesting on mangrove islands and feeding in the surrounding shallows. Few nest north of Florida Bay (Robertson 1978d), although a few now breed in Tampa Bay, which may be a recent event (Paul et al. 1975). The roseate spoonbill, another

coastal species, nests in Florida Bay with a few more in Tampa Bay. The population of 2,000 to 2,500 individuals appears to be stable. Loss of feeding areas in the Keys is cited as a potential problem for this fish-feeder (Ogden 1978b).

The bald eagle is a wide-ranging predator with a broad diet. However, within southwest Florida they clearly are most abundant in mangrove forests. As nesting sites elsewhere are lost through human disturbance, the importance of the eagles living in Everglades National Park and Florida Bay mangroves increases (Robertson 1978b). Of the 100 pairs now breeding in the eight-county study area, probably about half are in Everglades National Park. Bald eagles are primarily riparian, living near the coast or large lakes and rivers. Fish, water birds, and turtles form the bulk of their diet. The Florida population, once over 1,000 pairs, has declined by more than 50% in the past 30 years. The decline continues, although more slowly (Robertson 1978b).

The white-crowned pigeon is a Caribbean species whose northern limits are reached in southern Dade and Monroe Counties. Their habitats are mangroves, fringing forests, and interior hammocks, where they feed on fruit plucked from the tree canopy. Present in Florida primarily as a summer breeder, the species nests mostly on small islets where predation by terrestrial animals is reduced (Owre 1978a).

The Key Vaca raccoon is a distinct race restricted to the middle Florida Keys. Although they spend most of their time in red mangrove habitat, wooded and freshwater uplands probably are extremely important to their existence. Crustaceans and mollusks are their normal diet, but human garbage is now a common food source (Lazell 1978).

Two of the eighteen endangered vertebrates for which mangrove/marsh is primary habitat exist in salt marshes: The marsh hawk and Marian's marsh wren. The marsh hawk, which breeds only as far south as the central United States, winters in Florida (Peterson 1980). The marsh hawk forages for small rodents, birds, and insects by coursing low open prairies and marshes. Marian's marsh wren is a distinct race of the long-billed marsh wren. Its dwindling population is restricted to the gulf coast from Alabama south to Pinellas County, Florida. The Marian's marsh wren was formerly known to exist in Tampa Bay and Charlotte Harbor. Its existence today, especially as a breeder, is questionable. Salt water marshes dominated by Juncus and cordgrass are its sole habitat. Though territorial, the wrens breed in colonies. Northern populations of this species are migratory; but Marian's marsh wren probably is resident (Kale 1978b).

The American alligator is salt tolerant and ranges from its preferred freshwater habitats into brackish marshes. The Key deer often ranges into mangrove and marsh from the preferred island pineland habitat. Several wide-ranging predators (the black bear, panther, and bobcat) also occur in mangrove forest and salt marsh. They were discussed earlier under preferred habitats.

Prairie Grassland (13)

Large expanses of nearly treeless plains dominated by a variety of grasses form the prairie grasslands of southwest Florida. Differences in flooding frequency results in a gradation from wet prairies to dry prairies. Wet prairies are similar to freshwater marshes, but the water is shallower or absent and the dominant plants are grasses. Dry prairies sometimes have scattered patches of bayheads, cypress domes, or palm hammocks. The level substrate consists of shallow marl or sands that vary in depth, permeability, and acidity. Limestone often underlies prairie soils in Collier County. Fires retard the spread of shrubs and trees. Wiregrass (Aristida spp.), broomsedge (Andropogon virginicus), carpet grass (Axonopus affinis), saw palmetto (Serenoa repens), fetterbush (Lyonia lucida), and herbs are common. Prairie grassland once covered 4% (287 mi^2) of southwest Florida, mostly around Charlotte Harbor and in Collier County. Much of the wet prairie has been drained for use by cattle.

Listed vertebrates of prairie grasslands. Prairie grassland is primary habitat for four endangered vertebrates, of secondary importance to six others, and is one of many habitats used by five species.

P	Marsh hawk	S	Wood stork
P	Audubon's caracara	S	American kestrel
P	Sandhill crane		
P	Burrowing owl	X	Bald eagle
		X	Peregrine falcon
S	Little blue heron	X	Florida black bear
S	Snowy egret	X	Florida panther
S	Louisiana heron	X	Bobcat
S	American bittern		

Three of the vertebrates for which prairie grassland is primary habitat (Audubon's caracara, sandhill crane, and burrowing owl) have narrow habitat tolerances. All three have endemic populations confined to peninsular Florida. The marsh hawk, with broader tolerances, was discussed previously. The caracara, a large raptor, is the least numerous of the three, with a total population of about 400 individuals. It prefers dry prairies for foraging for vertebrate prey and carrion, and usually nests atop cabbage palms. The center of its range is east and north of the study area, but some occur in Manatee, Sarasota, Charlotte, Lee, and Collier Counties (Layne, personal communication).

The burrowing owl also prefers the dry portions of prairie grasslands. A predator on small vertebrates and large insects, the "ground owl" nests in burrows. The local water table must remain low enough to prevent flooding of burrows several feet below the surface. The draining of wet prairies may have enhanced populations of burrowing owls, but the development of other areas has countered this event (Owre 1978b). According to an annual census (1972-81) of these owls in the Tampa area, the population declined from 33 to 8 individuals because of development of natural habitat (Courser 1971-80).

The sandhill crane prefers wet prairie grasslands. Populations from the northern interior of North America winter in Florida. The Florida race Grus canadensis pratensis, listed as threatened by the Florida Game and Fresh Water Fish Commission, is a permanent resident. Cranes feed on grassland and marsh invertebrates, small vertebrates, and some plant food such as tubers and grain. The nest is a mound of aquatic vegetation, built in sloughs in water about 1 ft deep. Drying of sloughs during incubation, whether natural or man-caused, probably greatly increases nesting failure through predation. Though scarce in Monroe County, sandhill cranes almost certainly breed in all seven other counties in the study area (Williams 1978c).

Little blue herons, snowy egrets, Louisiana herons, and wood storks roam great distances to find optimum foraging conditions. Wet prairie grasslands are important feeding areas. The remaining species listed under prairie grasslands use it as secondary habitat or as one of many habitats. All are discussed elsewhere in the report.

Open Scrub Cypress (14)

Scattered dwarfed pond cypress (Taxodium distichum nutans) among stands of sawgrass (Cladium jamaicensis), beakrushes (Rhynchospora spp.), and wax myrtle (Myrica cerifera) characterize open scrub cypress. The substrate is regularly flooded marl or rock soils, which are nutrient poor. The relatively heavy rainfall is trapped by the nearly impervious limestone underlayer. Cypress swamp develops in wetter areas; hammocks, the drier areas. Hardwood and palm hammocks occur on slightly higher ground within scrub cypress habitat. Orchids and bromeliads are common in scrub cypress. This habitat covers 8% (564 mi^2) of the study area, all within Collier and Monroe Counties.

Listed vertebrates of open scrub cypress. Open scrub cypress is not primary habitat for any of the endangered vertebrates of southwestern Florida, but it is visited by several:

S	Mangrove fox squirrel	X	Florida black bear
		X	Florida panther
X	Eastern indigo snake	X	Bobcat

Four of the vertebrates listed have broad habitat tolerances and roam widely. The range of the mangrove fox squirrel encompasses the scrub cypress within the eight-county study area (Brown 1978a), and one author (Layne 1974) specifically refers to its occupying this habitat.

Freshwater Marsh (16)

Freshwater marshes vary from head-high stands of rushes and cattails to lush, low-growing expanses of broad-leaved plants. The substrate is organic muck that is usually flooded and nearly always saturated. Submergent and emergent herbaceous plants dominate. Arrowroot (Thalia geniculata), pickerel weed (Pontadaria lanceolata), various rushes, and arrowhead (Sagittaria spp.) are common. Numerous subtypes of freshwater marshes are recognized, based on the dominant plants: sawgrass (Cladium spp.) marsh, spike-rush (Eleocharis spp.) marsh, and cattail (Typha spp.) marsh, are examples. As mentioned,

marshes often intergrade into wet prairies. Freshwater marshes tend to occur as tiny patches within other habitats. Less than 1% of southwest Florida is freshwater marsh, the only extensive area being in eastern Collier County.

Listed vertebrates of freshwater marshes. This habitat, though comprising less than 1% of the study area and concentrated enough to show on the Davis map only in north Collier County, is primary habitat for 12 endangered vertebrates:

P	American alligator	P	American bittern
P	Key mud turtle	P	Wood stork
P	Little blue heron	P	Everglade kite
P	Snowy egret	P	Marsh hawk
P	Louisiana heron	P	Silver rice rat
P	Least bittern	P	Everglades mink

Five of the twelve have been discussed previously (little blue heron, snowy egret, Louisiana heron, and wood stork in the cypress swamp [7] section; marsh hawk in the mangrove swamp and coastal marsh [9]) section, as they have broader habitat tolerances than the other seven.

The Key mud turtle and silver rice rat have insular ranges; both are restricted to the Lower Keys. The turtle occasionally is found in other habitats, but is primarily aquatic, preferring sloughs and ponds with soft bottoms (Weaver 1978a). The silver rice rat is known only from Cudjoe and Parrot Keys, but is thought to occur on other islands south of the Seven Mile Bridge. Recent ditching and draining have eliminated potentially acceptable habitat (Spitzer 1978).

The American alligator is a top carnivore specialized for aquatic habitats. Fish, turtles, and many other aquatic vertebrates are included in its diet. Alligator holes may be important refuges for other animals during droughts. Although thousands of alligators inhabit the study area and occur throughout the southeast United States, their local rarity may influence the occurrence of other rare animals that rely on alligator holes as a water source during droughts.

The least bittern and American bittern are secretive waders of dense marshes. Least bitterns strongly prefer cattail marshes; American bitterns are found regularly in flatwoods ponds and sloughs that are dense with pickerel weed and arrowroot. The least bittern is a regular breeder in Florida. The American bittern only breeds sporadically; populations from farther north winter throughout the State. Both species feed on aquatic invertebrates and small vertebrates. Only the least bittern is included in the FCREPA report (Kale 1978a).

The everglade kite is a highly specialized freshwater marsh raptor. It feeds only on the apple snail (Pomacea). About 600 kites exist in the United States, all in Florida (Shapiro 1981). The population is centered outside of the study area, but some occur regularly in eastern Monroe and Collier Counties. Typical habitat consists of extensive areas of shallow, open waters with spike-rush, sawgrass, or cattails, and scattered shrubs or small trees

that serve as perches. Water must be present in the marsh throughout the year to sustain adequate numbers of apple snails. Kites nest in this habitat, building in shrubs, small trees, or cattails 1 or 2 m above the water (Sykes 1978).

The everglades mink occurs in only a few Florida counties south of Lake Okeechobee. Collier and Monroe Counties and the southeastern corner of Lee County constitute about half of the total range. The popultion is restricted to freshwater streams, lakes, and swamps. Little is known about the life history of this disjunct population. Certainly it is carnivorous, feeding mostly on small aquatic or wetland vertebrates and invertebrates. The everglades mink appears not to be numerous anywhere (Brown 1978d).

Everglades Region Marsh, Slough, Wet Prairie, and Tree Islands (16B)

The everglades habitat is a composite of wetlands dotted with slightly higher ground occupied by forests (tree islands). The lenticular-shaped tree islands gain their form from the local drainage pattern. Remains of sawgrass peat indicate that sawgrass (Cladium) communities once occupied the expanses between the tree islands. However, drainage and consequent oxidation of the peat since the early 1900's have resulted in a mixture of plant associations.

Except for the tree islands, the habitat usually is flooded in summer. The sloughs hold the deepest water. The substrate is mostly alkaline peat and marl, overlying limestone. Limestone outcrops are common.

Habitat subtypes include sawgrass marshes, spike-rush (Eleocharis) marshes, willow (Salix) heads, and bayheads. The tree islands may be typical swamp forest (8) or hammock (see below). Everglades habitat covers less than 1% (52 mi^2) of the study area, all in western Monroe County.

Listed vertebrates of everglades region marsh, slough, wet prairie, and tree islands (16B). Everglades habitat type constitutes only a tiny portion of the study area, in eastern Monroe County. However, this habitat is not scarce in Florida. It comprises the majority of Dade, Broward, and Palm Beach Counties (Davis 1967).

Seventeen listed vertebrates inhabit everglades habitat which comprises 1% of the study area. These same species also use marl and rockland marsh which comprises 9% of the study area. Discussion of these 17 vertebrates is deferred to the section on the more abundant of these two habitat types.

Wet to Dry Prairie Marsh on Marl or Rockland (17)

Prairie marsh has two major subtypes: sawgrass (Cladium) marsh, which grows on deep peat beds; and spike-rush (Eleocharis) marsh, which grows on shallow marl. The habitat, however, is extremely diverse in vegetative composition, with as many as 16 subtypes identified. Shrubs and grasses predominate in many places, and patches of hardwoods are frequent. Tree islands, bayheads, palm savannahs, cypress domes, and willow heads, all described previously, occur, but are not numerous. Water levels fluctuate extensively throughout the year. This habitat covers 9% (651 mi^2) of southwest Florida, all within Collier and Monroe Counties.

Listed vertebrates of wet to dry prairie marsh on marl or rockland. The 17 endangered vertebrates that use marl and rockland prairie marsh and also everglades habitat are:

P	American alligator	P	Marsh hawk
P	Little blue heron	P	Sandhill crane
P	Snowy egret	P	Cape Sable seaside sparrow
P	Louisiana heron	P	Everglades mink
P	Least bittern		
P	American bittern	X	Bald eagle
P	Wood stork	X	Florida black bear
P	Roseate spoonbill	X	Florida panther
P	Everglade kite	X	Bobcat

Thirteen of these species use both everglades and prairie marsh as primary habitat. Of these 13 species, all but the Cape Sable seaside sparrow move long distances to find optimum foraging conditions, and have been discussed previously. The Cape Sable seaside sparrow has narrow habitat tolerances; its entire range is confined to parts of mainland Monroe County and nearby southern Collier County. The Cape Sable sparrow lives in interior marshes that are fresh to slightly brackish. These marshes have open stands of cordgrass, spike-rush, salt grass, short sawgrass, or hair grass (Muhlenbergia capillaris). Fire is important as it eliminates brush and reduces density of the grasses, both of which are unsuitable to the sparrow. The Cape Sable seaside sparrow is a sedentary insectivore (Werner 1978).

Four far-ranging top carnivores, the bald eagle, bear, panther, and bobcat, all discussed previously, also forage in these marshes of Monroe and Collier Counties.

Hammocks

Hammocks are closed-canopy mesic hardwood forests. Southern magnolia (Magnolia grandiflora), laurel oak (Quercus laurifolia), American holly (Ilex opaca), blue beech (Carpinus caroliniana), and hophornbeam (Ostrya virginiana) are characteristic tree species of hammocks north of the everglades. Tropical hammocks occur in the everglades, on tree islands, and in the Florida Keys. Remnants exist north to Sarasota. Plant diversity is high. In tropical hammocks, 35 or more species of trees and 65 species of shrubs occur; vines, ferns, and air plants are common. Strangler fig (Ficus aurea), gumbo-limbo (Bursera simaruba), and mastic (Mastichodendron foetidissimum) are typical examples of trees.

North of the everglades, hammocks occur on rich, sandy soils, especially where limestone or phosphate outcrops exist. In the everglades and Florida Keys, hammocks usually are perched atop limerock. Fires are rare. Variation in soil moisture promotes plant diversity. Coastal hammocks occur in narrow bands, and often abut coastal marshes. Live oak/cabbage palm hammocks border lakes and rivers and often abut prairies. As this habitat was not mapped by Davis (1967), no calculation of area occupied was made, but probably it is less than 1%.

Listed vertebrates of hammocks. Many vertebrates live in hardwood hammocks. The habitat seems to be especially important for populations of wintering birds that breed farther north (Woolfenden 1968; Rohwer and Woolfenden 1969). Few of the endangered vertebrates of southwest Florida use this habitat, however. The major exceptions are the Key Largo cotton mouse and woodrat that are endemic to the Florida Keys. This list is as follows:

P	Miami black-headed snake	S	Ivory-billed woodpecker
P	White-crowned pigeon		
P	Key Largo cotton mouse	X	Eastern indigo snake
P	Key Largo woodrat	X	Florida black bear
		X	Florida panther

The little known Miami black-headed snake has been collected in tropical hammock habitat in the Keys (Campbell 1978b). The white-crowned pigeon, whose range extends north from the Caribbean into extreme south Florida, also uses tropical hammocks in the Keys (Owre 1978a). Both species were discussed earlier.

The Key Largo cotton mouse and the Key Largo woodrat, both distinct races of mainland species, are confined to mature tropical hammocks on Key Largo (Brown 1978b, c). The cotton mouse builds small spherical leaf-lined nests in logs, hollows, and rock crevices. The woodrat builds large stick nests on the ground. Both are herbivores, feeding on seeds, fruits, and buds of the many species of tropical plants that form their habitat.

The remaining species have been discussed previously. The ivory-billed woodpecker probably is extinct. The indigo snake still occurs in tropical hammocks in the Keys. The bear once existed in the upper Keys, but has been eliminated there (Layne 1974). The panther roams through all mainland habitats in southwest Florida, but it no longer occurs in the Keys (Layne 1974).

Estuaries

The estuaries of southwest Florida are shallow, and their coastal waters are protected from the open gulf by land formations. Four major estuarine complexes exist in the study area: Tampa Bay, bordered by Pinellas, Hillsborough, and Manatee Counties; Charlotte Harbor in Charlotte and Lee Counties; San Carlos Bay in Lee County; and Florida Bay in Monroe County between the mainland and the Keys. The tidal range is small, less than 1.2 m (4 ft) everywhere, and less than 1 ft in Florida Bay (Ross 1973). Vast expanses of tidal flats are exposed during low tide because of the overall shallowness of these estuaries. Salt marshes and primarily mangroves border the estuaries and provide important habitat and sources of nutrients for estuarine organisms. The submergent vegetation consists of several species of seagrasses and hundreds of species of algae. Those in Tampa Bay have been studied extensively (Dawes 1967, 1974; Humm 1973). The moderate water temperatures, neither cold in winter nor hot in summer, result in great diversity and abundance of marine life. Tampa Bay, for example, contains more marine species than any other estuary between Maryland and Texas (Taylor 1973, 1974; Simon 1974). For these reasons the estuaries of southwest Florida are important for resident and migratory vertebrates (Jones et al. 1973).

Listed vertebrates of estuaries. Fifteen listed vertebrates use estuaries as primary habitat. Five of these species (Atlantic sturgeon, Key blenny, common loon, peregrine falcon, and West Indian manatee) have not been discussed previously. Seven species are long-legged wading birds that roam widely in search of food, sometimes into freshwater habitats. Estuarine water habitats are secondary habitat for the American crocodile and Kemp's Ridley sea turtle. The list is as follows:

P	Atlantic sturgeon	P	Wood stork
P	Key blenny	P	Roseate spoonbill
P	Common loon	P	Peregrine falcon
P	Brown pelican	P	American oystercatcher
P	Great white heron	P	Least tern
P	Little blue heron	P	West Indian manatee
P	Reddish egret		
P	Snowy egret	S	American crocodile
P	Louisiana heron	S	Kemp's Ridley sea turtle

The Atlantic sturgeon lives along the east coast of North America as far south as northeast Florida. A separate subspecies (Acipenser oxyrhynchus desotoi) occurs in the northern gulf; it formerly ranged south to Tampa Bay. At present this subspecies of the Atlantic sturgeon is rare to absent as far south as the study area, but it still is common enough farther north along the gulf coast of Florida to sustain commercial fishing. Sturgeon spawn in freshwater, but spend most of their lives in the sea. The quality of breeding sites is critical to their continued existence (Gilbert 1978b), and natural establishment in the rivers that empty into Tampa Bay would require a clean Tampa estuary.

The Key blenny is known only from one locality, Looe Key in the lower Florida Keys. It inhabits channels near coral in shallow water. Its life history is presently unknown (Gilbert 1978c).

The common loon, which breeds on lakes in northern North America, winters in coastal waters, especially estuaries. Large numbers winter in the estuaries of southwest Florida. In spring, loons that have wintered farther south congregate in the estuaries of southwest Florida before flying north overland to their breeding grounds. Following a tanker oil spill in Tampa Bay in mid-February 1970, the author collected 70 dead loons (unpubl. data). The number killed probably was several times the number collected because only heavily oiled birds could be caught, only a few shorelines were searched, and death from oil can occur weeks after exposure to it.

Common loons feed on fish and portunid crabs. Loons arrive in southwest Florida in late fall and depart for the breeding grounds in early spring. Maturity is reached only after several years. A few immature loons summer in Florida.

Like loons, pelicans capture fish from the deeper waters of the estuaries. The seven species of long-legged wading birds forage in shallow water and capture smaller fish. The oystercatcher wades or searches exposed tidal flats and feeds on invertebrates. The least tern takes small fish from the water surface. These 10 species were discussed earlier.

The peregrine falcon roams widely and primarily preys upon medium-sized birds from many habitats. This predominantly coastal species is present in Florida only as a migrant and winter visitor. During the last decade (1971-80) a single peregrine was seen in three consecutive winters in Tampa Bay (Courser 1971-80). Twice the peregrine was seen capturing a sandpiper from the huge numbers that winter there (Woolfenden, personal observation).

West Indian manatees occur in estuaries, rivers, and near-shore gulf waters through southwestern Florida. Aerial surveys (Irvine et al. 1981) made in July through December produced records for all eight counties. Numbers ranged from 90 (including three calves) in September to 146 (including five calves) in November. For the 5 months surveyed combined, manatee sightings were most frequent for Monroe and Collier Counties and lowest for Pinellas, Manatee, and Charlotte Counties. Hartman (1978) estimated the total population along the gulf coast of Florida at 350 to 400 individuals. The majority of these would occur in the study area. Strictly herbivorous, manatees migrate between favored habitats and to warm waters such as springs and near power plants in response to cold. Their diet ranges from algae to terrestrial plants, but they prefer submerged vascular plants (Hartman 1978).

Two endangered reptiles, both discussed previously under other habitats, inhabit estuaries of southwest Florida: the American crocodile and the Kemp's Ridley sea turtle. In the United States crocodiles are confined to southern Dade, Monroe, and Collier Counties, where they inhabit mangrove swamps. Apparently they prefer quiet waters, but large individuals regularly enter deeper bays, especially at night, probably to feed on mullet (Ogden 1978d).

As previously mentioned, the Kemp's Ridley sea turtle breeds along a small segment of gulf beach in Mexico. During the summer, immature turtles occur along the gulf coast of Florida in sloughs, tidal flats, and channels. Data from the recapture of tagged females suggest adults also disperse throughout the gulf between breeding seasons. It is then that Kemp's Ridleys presumably occur within the study area (Lund 1974; National Fish and Wildlife Laboratory, no date).

GEOGRAPHIC DISTRIBUTION OF LISTED VERTEBRATE SPECIES

Fifty-three percent (36 of the 68 taxa) of the total number of listed vertebrate species in southwest Florida have broad ranges within the study area and have been recorded in all eight counties. Of the 36 taxa, probably only the Florida panther has experienced a population decline such that it no longer occurs throughout the study area. Five additional species occur in six or seven of the eight counties. The list of 36 with ranges that include all eight counties is as follows:

- Rivulus
- American alligator
- Leatherback sea turtle
- Kemp's Ridley sea turtle
- Loggerhead sea turtle
- Gopher tortoise
- Roseate spoonbill
- Bald eagle
- Marsh hawk
- Peregrine falcon
- American kestrel
- Sandhill crane

Eastern indigo snake
Common loon
Brown pelican
Magnificent frigatebird
Great white heron
Little blue heron
Reddish egret
Snowy egret
Louisiana heron
Least bittern
American bittern
Wood stork
Limpkin
American oystercatcher
Piping plover
Snowy plover
Roseate tern
Least tern
Burrowing owl
Red-cockaded woodpecker
River otter
Florida panther
Bobcat
West Indian manatee

The relatively small size of the study area (about 7,200 mi^2) coupled with the great mobility of many of these vertebrates (e.g., migratory birds) account for the numerous cosmopolitan ranges. Figure 3 summarizes by county the distributions of the 68 vertebrates. The minimum number of species in any county is 41 (60%) in Sarasota County; the modal number is 44 species (in Pinellas, Hillsborough, and Lee counties) or 65% of the total.

Monroe County exceeds the others in numbers of rare and endangered vertebrates present with 59 of the 68 species (87%), which is 12 more than the next highest number in adjacent Collier County. A similar distributional pattern of rare, threatened, and endangered plant species was noted by McCoy (1981) in Collier and Monroe Counties.

Southern Florida habitats are considered subtropical. Geographical isolation on islands such as the Florida Keys promotes the evolution of genetically distinct populations. The classic example is the Galapagos Islands off Ecuador. Islands that occur in a climatic regime different from the nearest mainland are even better situations for selection of distinct populations for species able to disperse to them. Thus the pristine Florida Keys represent a natural laboratory for the study of evolution.

Fourteen (20%) of the 68 endangered vertebrates are restricted to Monroe County. Nine of these 14 are endemic species or subspecies that occur only on certain islands of the Florida Keys. These are designated with the symbol I in the following list of rare, threatened, and endangered vertebrates restricted to Monroe County.

Key silverside I
Key blenny I
Key mud turtle I
Big Pine Key ringneck snake I
Red rat snake (Lower Keys)
Florida brown snake (Lower Keys)
Miami black-headed snake
Florida ribbon snake (Lower Keys)
White-crowned pigeon
Silver rice rat I
Key Largo cotton mouse I
Key Largo woodrat I
Key Vaca raccoon I
Key deer I

The listed snakes (red rat, Florida brown, and Florida ribbon snakes) with threatened Lower Keys populations also show genetic distinctions, but have not been described as subspecies. The white-crowned pigeon is a tropical, West Indian species. It reaches its northern limit in southern Monroe

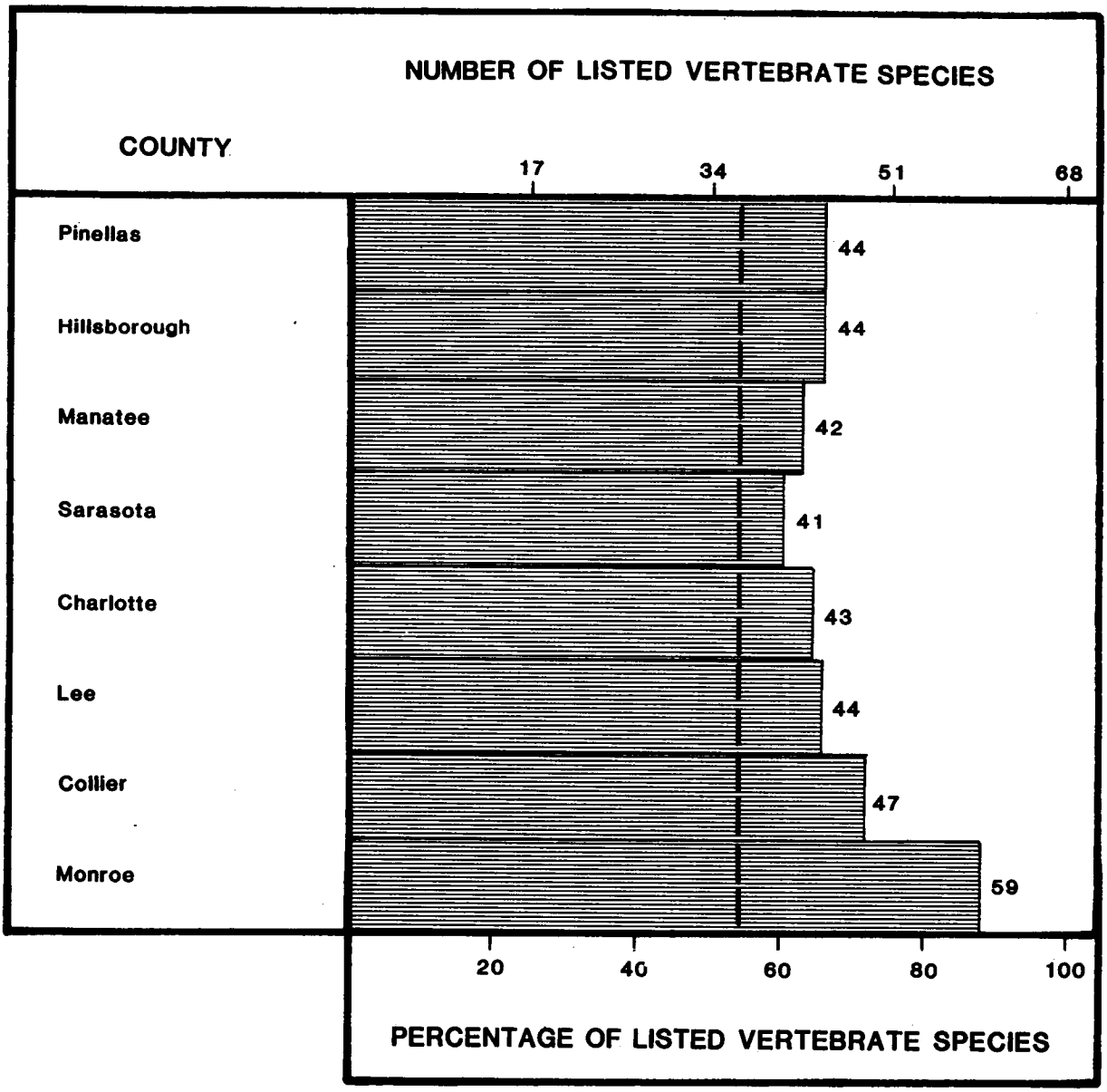

Figure 3. Distribution of the 68 rare, threatened, and endangered vertebrate species within the eight-county study area. Thirty-six of these 68 listed vertebrates have been recorded in all counties (dashed line).

County. Clearly, management considerations of the listed vertebrates of southwest Florida, and especially Monroe County, should take into account the biogeographical uniqueness of the Florida Keys.

HABITAT PREFERENCES OF THE LISTED SPECIES

To better understand the overall value of each habitat type in the study area to the listed vertebrate species of southwest Florida, the information

presented in the previous section and Table 4 is graphically portrayed in Figure 4. This figure shows the percent of species found in each habitat type and the percent of species for which each habitat is of primary importance.

Mangrove/salt marsh is first in importance in terms of all habitats used by the listed vertebrate species. Estuaries, everglades marsh, and marl/rock marsh are second in importance, followed by coastal strand habitats. Prairie grassland ranks next highest. Because many listed vertebrate species inhabit the wetter portions of prairies, this habitat, everglades marsh, and marl/rock marsh habitats can be arbitrarily grouped as interior wetlands. References to interior wetlands appear later in this report.

When only the primary habitat data for each species are considered, the habitat ranking results are strikingly similar to the rankings when all habitats used by the listed species are considered. Mangrove/salt marsh is first, estuaries are second, and everglades marsh and marl/rock marsh are third. Freshwater marsh ranks next highest, and is of primary importance to 18 species.

Pine flatwoods rank low, with only 9% of the total number of species occurring there. Pine flatwood is primary habitat for only one listed species (red cockaded woodpecker). Because of the overall abundance of pine flatwoods, however, it provides natural habitat corridors between patches of many of the scarcer habitats.

Twenty-eight of the rare and endangered vertebrates of southwest Florida are restricted to one primary habitat type identified in this report (Table 4). These 28 taxa include the five sea turtles, which are restricted to coastal strand or estuaries. Although their principal habitat is open marine waters, which are beyond the scope of this study, sea turtles must have acceptable coastal strand habitat to nest, and have been included for this reason.

Figure 5 shows the percent of the listed species restricted to one habitat type and the habitats in which they occur. Mangrove/marsh habitat and coastal strand both have the largest number of species that depend exclusively on one habitat, and estuaries the second largest number. This, in addition to the results shown in Figure 4, underlines the importance of coastal and interior wetland habitats to the listed vertebrates of southwest Florida. Coastal wetlands consist of estuaries usually bordered by mangrove, salt marsh, and coastal strand. Interior wetlands consist of non-forested wet prairie grassland, everglades marsh, and marl/rock marsh.

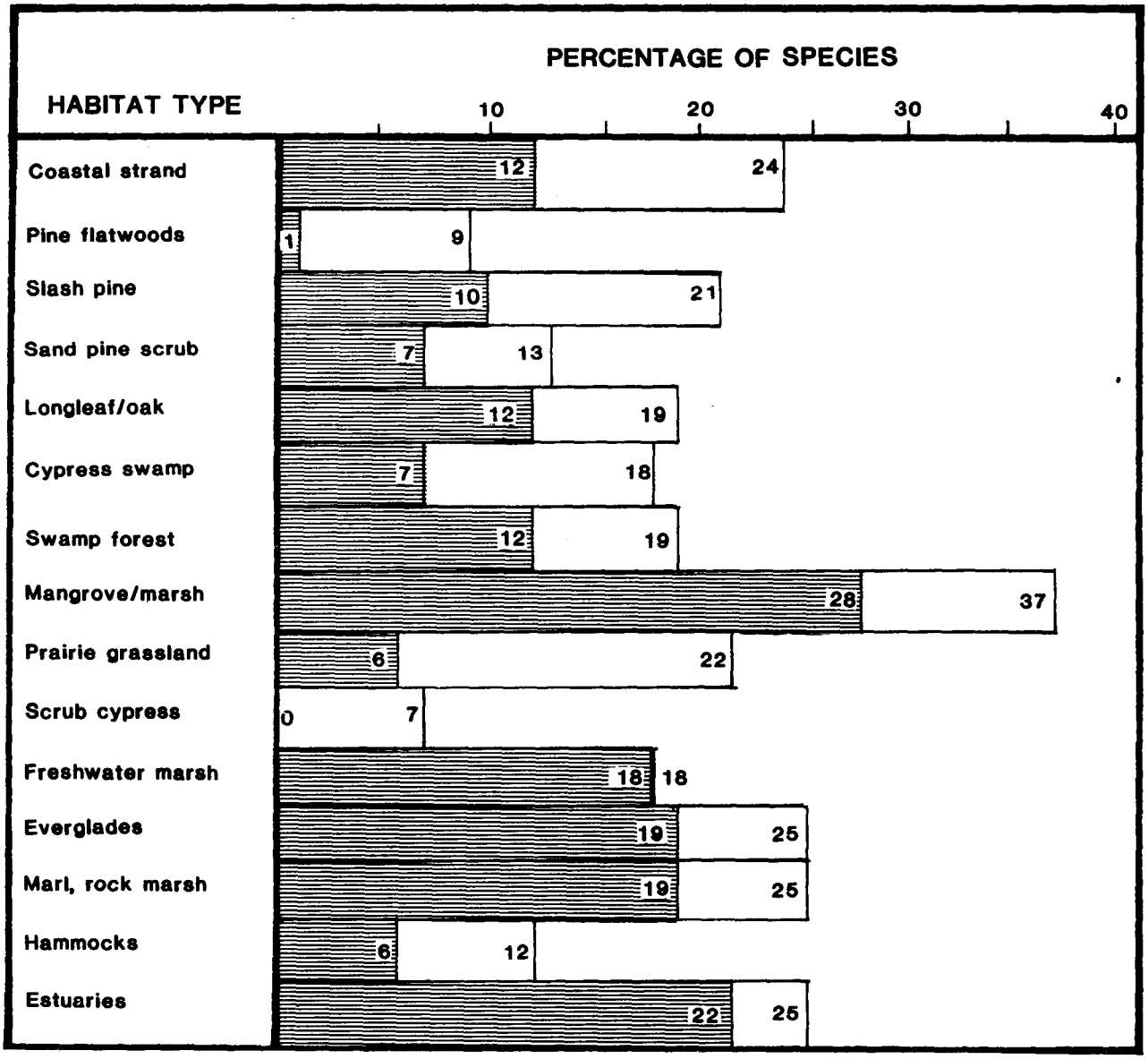

Figure 4. Percent of the listed vertebrates that occur in each of the 15 habitat types of southwest Florida (total bar). Shaded portion is percent of species for which the habitat is primary.

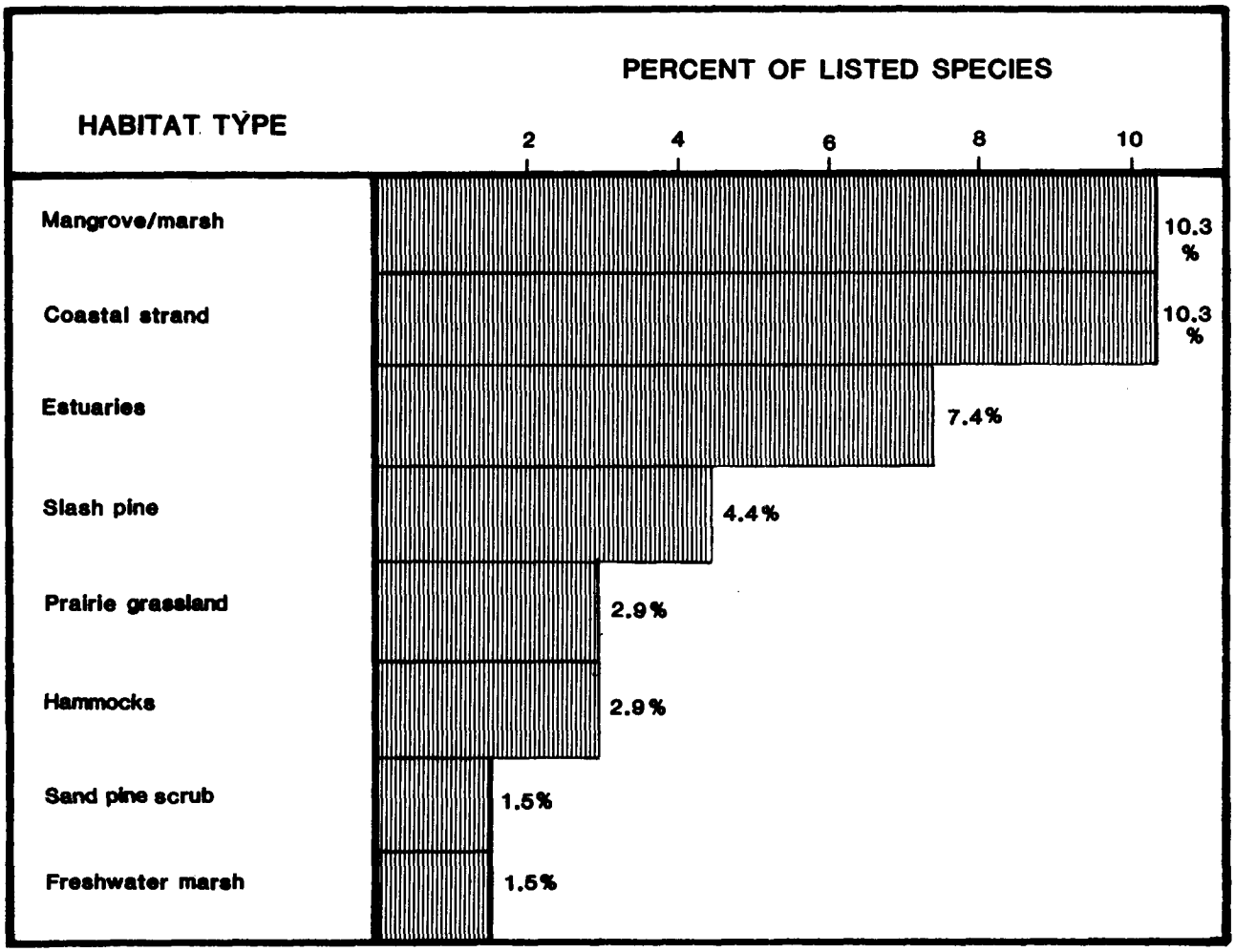

Figure 5. Percent of the listed species restricted to one habitat type.

CAUSES CONTRIBUTING TO POPULATION DECLINES OF LISTED VERTEBRATES OF SOUTHWEST FLORIDA

The three basic causes of population declines in the rare and endangered vertebrates of southwest Florida are destruction of habitat, direct exploitation by man, and incidental disturbance by man. Not one of the 68 vertebrates included in this report is thought to be facing extirpation because of natural events. Of the three causes identified, the most common reason for endangerment is habitat loss. The numerous authors of the species accounts in the FCREPA volumes (Pritchard 1978) list habitat loss as a cause for all but a few of the 63 vertebrates that are treated in this series. Possibly the only true exceptions are the Kemp's Ridley sea turtle and the peregrine falcon. The Kemp's Ridley sea turtle does not breed in Florida, its presence in the study area is restricted to nearshore waters and estuaries. The peregrine falcon roams widely. Furthermore, it is capable of coexisting with man if its nests are not disturbed and if the environment is relatively free of pesticides (Hickey 1969). It occurs in the study area only as a migrant and non-breeding resident.

DIRECT EXPLOITATION AND INCIDENTAL DISTURBANCE

Direct exploitation, defined as the intentional removal of individuals from wild populations for human use, and incidental disturbance, defined as the loss of wild individuals from relatively intact habitats because of human activities, effect many of the rare and endangered vertebrates of southwest Florida. Recently, the Florida Game and Fresh Water Fish Commission published a revised list of the "endangered wildlife" (i.e. vertebrates) of the State (Shapiro 1981). The official State list now includes 67 threatened or endangered vertebrates, of which 42 occur in southwest Florida. The Shapiro report mentions causes for declining populations additional to, or other than, habitat loss for 23 vertebrates. These 23 vertebrates and the human causes for their declines are listed in Table 5. The causes are categorized under direct exploitation or incidental disturbance.

Only four of these 23 vertebrate populations are listed by the Florida Game and Fresh Water Fish Commission as declining from direct exploitation: green and loggerhead sea turtles are taken for food, the hawksbill sea turtle for its shell, and the eastern indigo snake is captured for the pet trade. Certain forms of direct exploitation common in the past are rare today. The great white heron, reddish egret, snowy egret, roseate spoonbill, and to a lesser extent other long-legged waders were killed in huge numbers for their plumes in the 1800's. This practice was made illegal and ceased early in the 1900's, and the wader populations later increased to a peak in the 1930's. Decreases that have occurred since then are attributed to habitat alteration (Robertson and Kushlan 1974).

Table 5. Threatened and endangered vertebrates of southwest Florida whose populations are reduced by human interference, direct and incidental.

Threatened or endangered vertebrate	Direct exploitation	Incidental disturbance
Key silverside		exotics
Leatherback sea turtle		nest site
Green sea turtle	food	nest site
Hawksbill sea turtle	shell	nest site
Loggerhead sea turtle	food	nest site
Eastern indigo snake	collecting	
Brown pelican		nest site
Wood stork		water tables
Everglade kite		shooting
Bald eagle		shooting
Audubon's caracara		vehicles
Peregrine falcon		shooting, pesticides
Sandhill crane		nest site
Snowy plover		nest site
Roseate tern		nest site
Least tern		nest site
White-crowned pigeon		shooting
Red-cockaded woodpecker		timber management
Florida scrub jay		fire suppression
Cape Sable seaside sparrow		feral cats and dogs
Florida black bear		persecution
Florida panther		persecution
West Indian manatee		boating, harassment

[a]Florida Game and Fresh Water Fish Commission (Shapiro 1981).

Twenty-two of the 23 listed vertebrates of southwest Florida are declining in part because of incidental human disturbance. These include the three sea turtles that are also declining because of direct human exploitation. The Key silverside is declining because of unsuccessful competition with exotic fishes introduced into its environment. Sea turtle nesting is damaged by artificial lighting near nesting beaches and other more immediate human disturbances. Colonial nesting birds such as the pelican and terns experience reproductive failures because of visits to the nesting sites by humans. Several predators, birds and mammals, are persecuted and killed by wanton shooting and misinformed conservationists. Vehicle traffic, boating, fishing line, pesticides, and a myriad of other incidental human disturbances also cause unnatural deaths.

Broadly considered, these "incidental" factors reflect degradation of habitat. A habitat is far from natural if, for example, it is subjected to frequent boat traffic, if it is laced with high-speed roads, or flooded with artificial illumination. Thus, habitat loss ultimately accounts for nearly all problems with the rare and endangered vertebrates of southwestern Florida.

HABITAT LOSS

Loss of habitat sufficient to maintain viable populations is specified as the major cause for listing nearly all of the rare and endangered vertebrates in the FCREPA volumes (Pritchard 1978). Loss of natural habitat and its presumed converse, preservation of habitat, are analyzed geographically by county in Table 6, and by habitat for southwest Florida as a unit in Table 7. Because most of the 68 rare and endangered vertebrates are broadly distributed throughout southwest Florida, their habitats within the study area can be analyzed as a unit rather than separately by county.

Florida is the eighth largest state in terms of human population and it has a high growth rate. It ranks 25th in amount of land devoted to agriculture. Certain industries also use huge tracts of land. Phosphate mining is a prime example (Layne et al. 1977); significant portions of Hillsborough and Manatee Counties are subject to or are scheduled for phosphate mining. Smaller scale disturbances result from installations such as power plants, sewage plants, and roadways. Land development is most extensive around Tampa Bay at the north end of the study area, and preservation is most extensive to the south. Large tracts of preserved land are Big Cypress Swamp in Collier County and Everglades National Park in Monroe County (Figure 1).

The habitats represented in the eight southwestern Florida counties range from upland habitats in the north to low, wetland habitats in the south (Figure 2). Since preservation is greatest in the southern two counties (Collier and Monroe), it is lowland habitats that show the highest percentage of preservation (Table 7). Seven of the 13 habitats listed show more than half of their total areas as preserved: southern slash pines, scrub cypress, and everglades marsh, 100%; freshwater marsh, 95%; marl and rockland marsh, 89%; mangrove/marsh, 63%; and cypress swamp, 51%.

Table 6. Areal extent (mi^2) and percentage of each county under development (agricultural, urban), preserved, or designated for other human uses (from Thompson 1979).

County	Total	Agricultural		Urban		Preserved		Other uses[a]	
	mi^2	mi^2	%	mi^2	%	mi^2	%	mi^2	%
Pinellas	265	41	15	135	51	23	9	66	25
Hillsborough	1038	564	54	145	14	40	4	289	28
Manatee	740	366	49	54	7	64	9	256	35
Sarasota	587	317	54	67	11	57	10	146	25
Charlotte	703	273	39	40	6	138	20	252	35
Lee	785	161	21	82	10	33	4	509	65
Collier	2006	376	19	31	2	1128	56	471	23
Monroe	1034	1	-	6	1	1028	99	-	0
Total	7158	2098	29	560	8	2511	35	1989	28

[a]e.g., industrial uses such as phosphate mining, power plants, sewage plants, roadways.

Even though some habitats are apparently well preserved in southwest Florida, numerous insidious forms of destruction persist. The foremost of these are changes that indirectly alter hydrologic regimes. Road and railway beds retard or alter sheet flow of water. Paving prevents percolation and promotes run-off. Leveling low, flood-prone areas restricts recharge of ground waters. Many agricultural, mining, and municipal activities lower aquifers. These and related human activities directly affect the numerous rare and endangered vertebrates in the study area whose existences require standing water (McPherson et al. 1976).

Table 7. Percentage of each habitat under development (urban and agriculture), preserved, or designated for other human uses.

Habitat	Total area (mi^2)	Percent urban and agriculture	Percent preserved	Percent other uses
Coastal strand	132	53	26	21
Pine flatwoods	3437	57	9	34
S. slash pines	192	-	100	-
Sand pine scrub	80	40	-	60
Longleaf/oak	435	55	1	45
Cypress swamp	219	24	51	25
Swamp forest	227	19	19	62
Mangrove/marsh	842	20	63	17
Prairie grassland	287	37	7	56
Scrub cypress	564	-	100	-
Freshwater marsh	40	-	95	5
Everglades	52	-	100	-
Marl, rock marsh	651	-	89	11

[a]The figures are estimates derived from information obtained from (Davis 1967, FDA 1976, Geological Survey 1976, Layne et al. 1977, USDA 1978, McCoy 1981).

[b]e.g., industrial uses such as phosphate mining, power plants, sewage plants, roadways.

The decline of wading birds, including the herons, egrets, stork, and spoonbill treated herein, within Everglades National Park illustrates this point (Robertson and Kushlan 1974). Pre-plume-hunting population estimates of 2,500,000 waders plumeted to 500,000 by 1910 because of hunting. Recovery reached its peak in the 1930's when populations were estimated at 1,200,000 individuals. Current low estimates of 500,000 are attributed to drying of the everglades (Robertson and Kushlan 1974). This theory is supported by comparing population levels in marine habitats, especially Florida Bay with the interior freshwater habitats of Everglades National Park (Robertson and Kushlan 1974). While estuarine populations have increased during the past several decades, and probably are near carrying capacity, those nesting in the interior have declined as their habitat has become smaller and less stable.

HUMAN POPULATION TRENDS

Not only is Florida a populous state, but the population is rapidly increasing. The eight southwestern counties make a major contribution to this trend. Table 8, which lists past population sizes and estimates future population sizes (Thompson 1979), shows the region's human population doubles about every 20 years. The northernmost two counties in the study area, Pinellas and Hillsborough, are already the most populous and are expected to have the greatest increases in numbers.

Certainly a correlation exists between increasing human populations and loss of natural habitats, and it is logical to assume the correlation is a cause and effect relationship. Furthermore, because loss of natural habitats is the most important cause for declining populations of rare and endangered vertebrates, it is logical to predict that more vertebrates will join those already determined to be rare or endangered and those already endangered will decline further in numbers.

AREA, NUMBERS, AND VIABLE POPULATIONS

Only careful, long-term studies of each vertebrate can determine how much habitat and how many individuals are needed to sustain a population. Unfortunately such studies are almost non-existent. Current knowledge, however, does permit making a few generalizations. To exist, some vertebrates require large tracts of natural habitats within which their densities are extremely low. In southwest Florida, large mammalian carnivores, such as the Florida panther and black bear, fit this category. Fortunately these animals use a variety of habitats and probably can exist in low numbers for long periods of time. Many of the highly social listed vertebrates also require large tracts of acceptable habitats to sustain their populations. Several of the long-legged wading birds, for example, roam in large groups over extensive wetlands to find proper feeding conditions (Robertson and Kushland 1974). Species endemic to the Florida Keys are restricted to small groups of islands. Careful preservation of these small sites would probably be sufficient to maintain self-sustaining populations there.

Table 8. Human populations, 1960-2000, for the eight south Florida gulf coast counties (data from Thompson 1979).

County (North to south)	Population (1000's)					Population density (100's/mi²)		Average % increase per decade
	1960	1970	1980	1990	2000 (projected)	1960	2000 (projected)	
Pinellas	374.7	522.3	749.7	934.9	1087.0	14	41	31
Hillsborough	397.8	490.3	644.0	783.5	910.9	4	9	23
Manatee	69.2	97.1	144.0	181.1	210.9	1	3	32
Sarasota	76.9	120.4	197.5	254.5	295.9	1	5	41
Charlotte	12.6	27.6	55.3	74.1	86.2	1	1	67
Lee	54.5	105.2	198.2	262.7	305.5	1	4	57
Collier	15.8	38.0	82.8	112.4	130.7	1	1	78
Monroe	47.9	52.6	56.5	64.2	74.7	1	1	12

POTENTIAL IMPACTS OF OCS DEVELOPMENT

Two scenarios have been projected to accompany Outer Continental Shelf (OCS) oil exploration and development off the southwest coast of Florida over the next several years. These are described in the Environmental Impact Statements for OCS oil and gas sales (BLM 1980, 1981):

(1) Little or no oil found; no development beyond exploration
(2) Substantial oil found; onshore pipeline and storage facilities and offshore drilling platforms constructed.

Offshore oil development facilities currently exist at Port Manatee inside the mouth of Tampa Bay at the Hillsborough-Manatee County line (Figure 1). If little or no oil is discovered off southwest Florida, then additional onshore development will probably not occur. If an economically productive oil/gas reservoir is discovered, exploration and production would increase, and additional onshore service/supply bases might be needed. These bases usually are located within 241 km (150 mi) of offshore petroleum fields. Depending on the location of the OCS discovery, onshore development might require expansion at Port Manatee, or the establishment of facilities elsewhere along the southwest coast of Florida (e.g., Fort Myers, Key West). This section discusses the potential impacts of these possibilities on the habitats of the listed vertebrate species of southwest Florida.

POTENTIAL ADVERSE EFFECTS OF OCS ACTIVITIES

Three aspects of offshore oil/gas development that are potentially harmful to the habitats of southwest Florida: (1) onshore development, (2) pipeline construction, and (3) oil spills.

Onshore Development

Onshore facilities could occupy an estimated 20 to 41 ha (50 to 100 acres) (Pearman and Stafford 1975; BLM 1980) and employ 100 to 1,000 people. Facility size and the number of employees will vary directly with the degree of OCS development. The lower estimates are for small-scale exploration; the higher for relatively large-scale production (32 platforms). Onshore facilities normally include offices, warehouses, materials storage, parking, loading docks, crane service, helipads, and fuel and water storage. Ancillary activities include increased boat traffic and possibly channel deepening.

Direct effects of onshore development on the listed vertebrate species are limited primarily to the alteration of habitat for construction and increased disturbance caused by helicopter and boat traffic. The species most likely to be affected by boat traffic is the West Indian manatee.

Pipeline Construction

Pipelines and ships are used to transport oil from offshore platforms to onshore storage facilities. If production is sufficient, the additional cost required to construct a pipeline may be warranted. Present OCS operating regulations require that a pipeline be buried where water depths are less than 70 m (200 ft). Burial requires dredging or trench digging which poses environmental problems during construction (BLM 1980, 1981). Based on the volume of oil transported, pipelines have a somewhat lower spillage rate than ships. Pipeline construction probably would cause little damage to the terrestrial habitats. Small losses of mangrove/marsh probably would be the major impact. Of course, the associated boat traffic would disturb estuarine species, of which the manatee is potentially the most vulnerable of the listed vertebrates.

Oil Spills

Oil spills can result from rig blowouts, pipeline rupture or leakage, spillage during transfer, and shipping accidents. Safety devices to prevent blowouts and the burial and coating of pipelines to retard corrosion have significantly reduced spillage from these sources. New sensing devices and inspection techniques have also helped. Spills resulting from carelessness or accidents still remain.

Oil spills resulting from tanker accidents or offshore platform blowouts receive the most publicity. Millions of tons of petroleum, however, also enter marine environments from numerous other sources (National Academy of Sciences 1975; American Institute of Biological Sciences 1976). About one-third of the total petroleum entering the sea stems from transportation activities, of which tanker accidents constitute only a small part. River and urban run-off accounts for another third; the remainder comes from coastal oil refineries, offshore production, natural seeps, atmospheric fallout, and other minor sources (Bolen 1981).

The environmental impact statement (BLM 1981) prepared for the OCS oil and gas sales considered in this report, calculated a risk of 0.37 for oil spills in excess of 1,000 barrels during the 13-year mean production life of the proposed leases. An earlier evaluation (BLM 1978) concluded that tracts off Florida's west coast pose no significant risk of oil landfalls from an average spill within 3 or 10 days, and only minimal risk within 30 days of the spill.

Sites of oil spill landfall are proposed to be distributed rather evenly from the Florida panhandle (Cape San Blas) to Cape Romano, and from Big Pine Key to Key West. A 30-day delay to landfall will lessen the impact of potential spills by natural weathering, and will allow time for containment and cleanup (BLM 1980).

Predicting oil spill impacts is tenuous because little data are available. Pearman and Stafford (1975) cited numerous variables that alter the effects of oil spills: spill location, time of year, and proximity to shore are examples. In the Gulf of Mexico, winds blow onshore during spring and

early summer, and offshore starting in late summer. During summer, convective thunderstorms produce high winds and waterspouts. During summer and fall, hurricanes often occur in the gulf that could drive oil onshore rapidly, even without the hurricane making landfall. The seasonality of these weather events suggests that rapid landfall of oil spilled offshore would be greater in summer than in other seasons (Pearman and Stafford 1975).

Most oil spills are small. The U.S. Coast Guard estimated that 96% of all spills are less than 1000 gal, and most of these are less than 100 gal (Kash et al. 1973). The Tampa Port Authority records hundreds of spills annually in Tampa Bay; few exceed 50 gal (Pearman and Stafford 1975; Hershner and Lake 1980). Frequent small spills result in constant low levels of oil in the environment. The chronic effects of low levels of oil on natural habitats, and specifically tropical habitats, are virtually unknown.

HABITATS OF RARE, THREATENED, AND ENDANGERED VERTEBRATES LIKELY TO BE AFFECTED BY OCS DEVELOPMENT

Of all the potential consequences of OCS development, oil spills would be the most harmful to habitats of the listed vertebrates of southwest Florida. Of the 15 major southwest Florida habitats, those contiguous with open gulf waters that will be affected by oil spills are coastal strand, mangrove swamp/coastal marsh, and estuaries. The importance of these three habitats to the listed vertebrate species of southwest Florida is revealed in three previous analyses based on Table 4 and Figures 4 and 5. Mangrove/marsh habitat ranks first in overall distribution of listed vertebrate species (Figure 4); estuarine habitat is tied for second; and coastal strand ranks third. Of the habitat types of primary importance (Figure 4), again mangrove/marsh ranks first and estuaries second, while coastal strand ranks sixth. When ranks are established based upon the species restricted to one habitat type (Table 4), mangrove/ marsh and coastal strand are tied for first and estuaries is second (Figure 5). Forty of the 68 listed vertebrates (59%) of southwest Florida inhabit mangrove swamp/coastal marsh, estuaries, or coastal strand, with some species inhibiting two or all three of these habitat types.

Oil in the marine environment can be harmful to marine vertebrates if ingested when feeding, drinking, or preening. Oil is also harmful when indirectly consumed through food chains. Although the effects of oil on vertebrates are the subject of much current research, little is known about the results of oil spills on these animals and their habitats. Oil-contaminated sediments also certainly have residual toxicity to invertebrate populations, and oiled hard surfaces are not colonized easily by attaching organisms (Nadeau 1977). Mangrove swamps, coastal marshes, and estuarine seagrass beds produce large amounts of organic material that provides the detrital source for food webs in shallow marine waters (Bolen 1981). If oil in marine waters is harmful to mangroves, marsh grasses, seagrasses, and their associated invertebrates, then indirectly it is harmful to numerous vertebrate species associated with marine habitats.

One ancillary effect of OCS activities is that additional demands will be placed on freshwater reserves. Apparently the demands would not be great,

with needs estimated at 16 to 26 million gallons per year, comparable to the amount used by a golf course. Lowered water tables negatively affect all habitats, especially wetland habitats. The consequences of water withdrawal to south Florida and the effects on rare, threatened, and endangered plants are described by McCoy (1981).

An important but more complex and subtle factor is the increase in human population in southwest Florida. A larger human population means increased water use, boat traffic, and use of beaches, which will further stress populations of listed vertebrate species. Furthermore, Pearman and Stafford (1975) estimated that even small-scale production without a refinery may have an adverse economic impact on the region. It is logical to predict that for economic reasons, an expansion of facilities would be requested. Naturally, this expansion would further stress the habitats of southwest Florida.

In summary, the effect of onshore development will be the direct loss of habitats developed for OCS activities. Oil spillage remains the most serious potential impact, and land falls of oil would most likely contact the coastal habitats such as mangrove/marsh estuaries, and coastal strand. These same habitats are of the greatest importance to the listed vertebrates discussed in this report.. Negative impacts of these species are indeed possible, and the extent of the impacts will depend upon the magnitude of oil spilled and habitat destroyed. All efforts to protect these habitats should be made.

PORT MANATEE OR BOCA GRANDE AS THE LOCATION FOR ONSHORE OCS FACILITIES

During previous eastern gulf OCS exploration activities in the mid-1970's, onshore operations were centered at Port Manatee, near the mouth of Tampa Bay. Port Manatee presently possesses a 40-ft deep channel and petroleum storage facilities used by a local electric utility (Pearman and Stafford 1975). If OCS crude oil were to be transported onshore, additional processing and storage facilities would be required. With maximum flow, storage capacities for several million barrels would be required and considerable expansion of the facility would be necessary.

Port Manatee lies at the mouth of a busy seaport in an area of extensive urban development (Figure 6). Despite this location, portions of upper Tampa Bay, such as McKay and Old Tampa Bays, are important sources of seafood for humans, and refuges where wildlife, including migratory birds, congregate (Woolfenden and Schreiber 1973). Boca Grande has a shallower channel than Port Manatee, and its storage facilities possess a capacity of less than one million barrels. Charlotte Harbor, the location of Boca Grande, is far less urbanized than Tampa Bay (Figure 6).

The distributional information on the listed vertebrates and their habitat associations in southwest Florida is pertinent when considering the best of the two locations for onshore oil storage facilities. A north to south geographical trend is evident in the distribution of terrestrial habitats: interior and coastal wetland habitats are more common to the south (Figure 2 and Table 3). The geographic distribution of listed vertebrates by county shows a concentration in the south, especially in Monroe County (Figure 3). Fifteen of the 68 species treated herein are restricted to this county.

The most important problem is oil spills that occur within the ports themselves. Associated problems are pipeline construction, increased boat traffic, and increased human activity near the port. Because the rare and endangered vertebrates and their habitats are more abundant farther south along the coast, because major wildlife preserves (e.g. Everglades National Park) are located farther south, and because less additional development is necessary to use the Tampa Bay facility, it is concluded that Port Manatee is the better choice for the OCS onshore installation.

Recently McCoy (1981) completed a study of 274 ecologically sensitive plant species and their habitats in the eight southwest Florida coast counties. His major conclusions were: (1) relatively greater concentrations of these plants occur in Collier and Monroe Counties; (2) relatively fewer concentrations of these plants occur in Sarasota and Charlotte Counties; (3) relatively greater concentrations of these plants occur in coastal habitats (coastal strand, mangrove swamp/coastal marsh) in the southern three counties; (4) relatively greater concentrations of these plants occur in freshwater habitats in the southern two counties and northern three counties.

Clearly these general characteristics are similar to those of the listed vertebrates, where the southern portion of the study area and the wetland habitats are most important. McCoy's study dealt only with terrestrial plants. Therefore, estuarine habitats were not included in his report. However, mangrove swamps/coastal marsh habitat was identified by McCoy as one of the habitats most important to ecologically sensitive plants of southwest Florida.

Causes of rarity for the plants are removal by humans and loss of habitat. Both are causes of rarity for the listed vertebrates, although collecting seems to affect more plant than animal species.

McCoy concluded that the effects of OCS activities will be negligible, apart from the potential danger of a large oil spill or many chronic, small spills. The inclusion of estuaries in the analysis of vertebrates and their habitats places additional emphasis on the potential harm of oil spillage in coastal waters, regardless of the location of onshore OCS facilities.

Study of the ecologically sensitive plants and the rare and endangered vertebrates of southwest Florida leads to the same conclusion regarding location of the onshore facility. Because endangered biota is largely concentrated in south Florida, and especially because the endangered coastal organisms are concentrated to the south, Port Manatee near the northern end of the study area is a better location for an onshore facility. This recommendation is made with the additional comment that the upper reaches of Tampa Bay are important sources of human food and important habitat for many thousands of migrant waterbirds.

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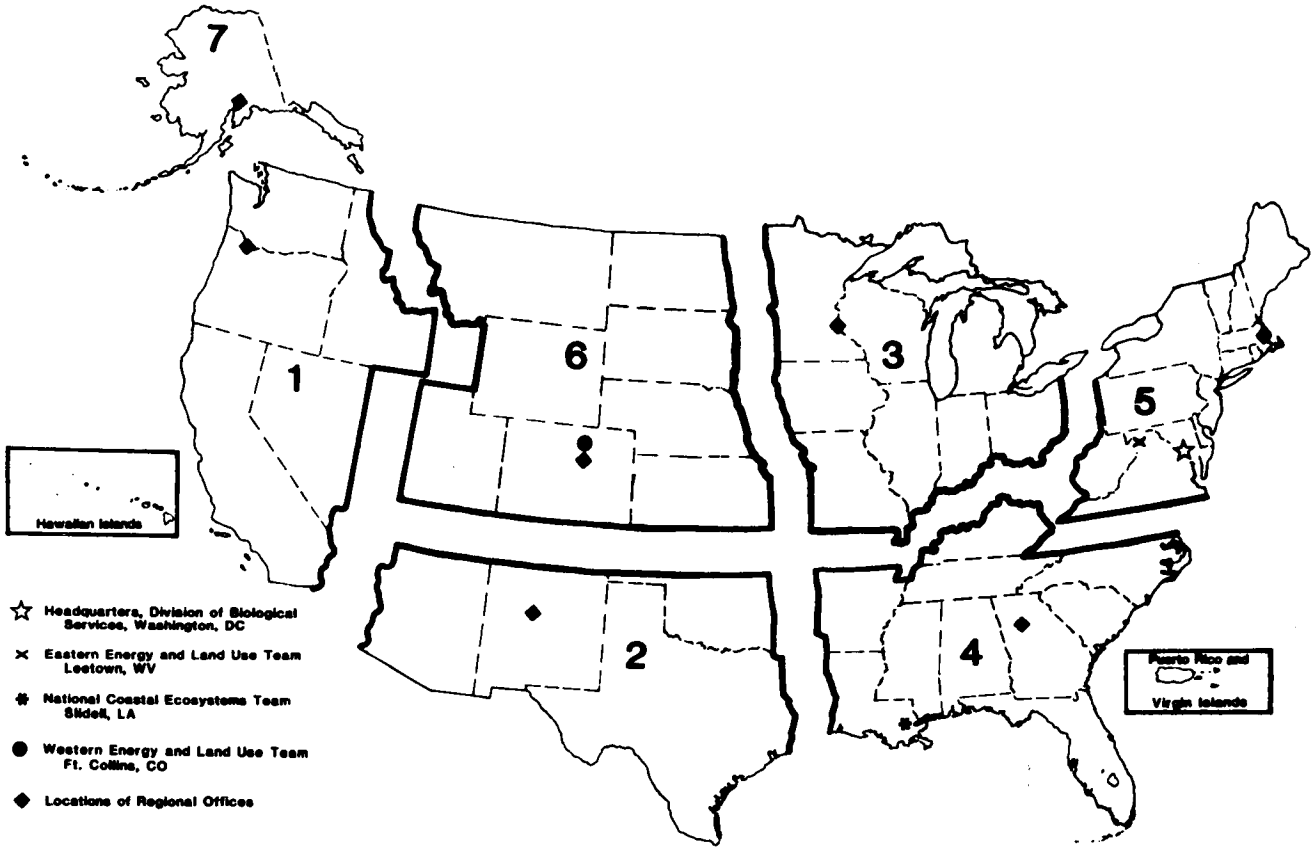

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Regional Director
U.S. Fish and Wildlife Service
P.O. Box 1306
Albuquerque, New Mexico 87103

REGION 3
Regional Director
U.S. Fish and Wildlife Service
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

REGION 4
Regional Director
U.S. Fish and Wildlife Service
Richard B. Russell Building
75 Spring Street, S.W.
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REGION 5
Regional Director
U.S. Fish and Wildlife Service
One Gateway Center
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REGION 6
Regional Director
U.S. Fish and Wildlife Service
P.O. Box 25486
Denver Federal Center
Denver, Colorado 80225

REGION 7
Regional Director
U.S. Fish and Wildlife Service
1011 E. Tudor Road
Anchorage, Alaska 99503

DEPARTMENT OF THE INTERIOR
U.S. FISH AND WILDLIFE SERVICE

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.